REPORT RESUMES

ED 014 559 VT 002 795

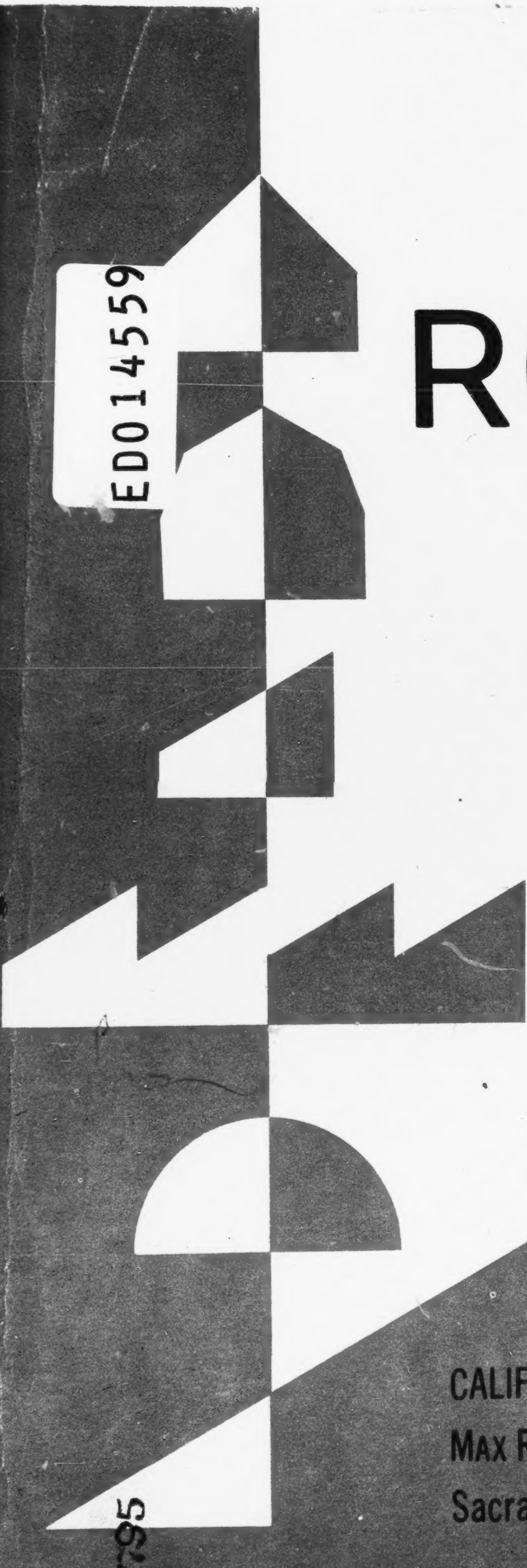
ROOFING, PART 2. WORKBOOK.
BY- WOLTJES, WILLIAM AND OTHERS
CALIFORNIA STATE DEPT. OF EDUCATION, SACRAMENTO
PUB DATE 67

EDRS PRICE MF-$1.00 HC-$10.28 255P.

DESCRIPTORS- *STUDY GUIDES, *TRADE AND INDUSTRIAL EDUCATION, *APPRENTICESHIPS, *ROOFERS, *ROOFING,

THE TECHNICAL INFORMATION IN THIS STUDY GUIDE WAS PLANNED UNDER THE DIRECTION OF THE STATE EDUCATIONAL ADVISORY COMMITTEE FOR THE ROOFING TRADE AND WRITTEN BY AN APPRENTICE TRAINING SPECIALIST AND OTHERS TO BE USED AS RELATED CLASSROOM INSTRUCTION IN THE APPRENTICE TRAINING PROGRAM FOR ROOFERS. THE UNITS INCLUDE (1) BUILT-UP ROOFING, DAMPPROOFING, AND WATERPROOFING, (2) COMPOSITION SHINGLING, (3) RIGID ROOFING, (4) BLUEPRINT READING, (5) ESTIMATING, AND (6) EXERCISES IN ESTIMATING. EACH UNIT IS DIVIDED INTO TOPIC ASSIGNMENTS. A TYPICAL TOPIC HAS AN INTRODUCTION OF BACKGROUND INFORMATION AND A LIST OF QUESTIONS TO BE ANSWERED, A SECTION OF RELATED MATERIAL, A REVIEW OF SAFETY RULES AND PRECAUTIONS, A STUDY ASSIGNMENT FROM A REFERENCE BOOK, A LIST OF QUESTIONS FOR GROUP DISCUSSION, A STUDY GUIDE OF EXERCISES TO BE COMPLETED, TRUE-FALSE QUESTIONS TO BE USED FOR STUDENT SELF-EVALUATION. THE STUDY OF THIS 144-HOUR COURSE BY INDENTURED APPRENTICES ON A GROUP OR INDIVIDUAL BASIS IS TO BE DIRECTED BY A QUALIFIED JOURNEYMAN OF THE TRADE. PHOTOGRAPHIC AND LINE-DRAWING ILLUSTRATIONS AND SUPPLEMENTARY INSTRUCTIONAL MATERIALS ARE IN EACH TOPIC. SUPPLEMENTARY ART ILLUSTRATIONS ARE PROVIDED IN A SEPARATE SECTION. TESTBOOKS AND FINAL EXAMINATIONS ARE AVAILABLE TO THE INSTRUCTOR. THIS DOCUMENT IS ALSO AVAILABLE FOR $2.50 FROM BUREAU OF INDUSTRIAL EDUCATION, CALIFORNIA STATE DEPARTMENT OF EDUCATION, 721 CAPITOL MALL, SACRAMENTO, CALIFORNIA 95814. "ROOFING, PART 1," VT 002 987, IS ALSO AVAILABLE. (HC)

ED014559



ROOFING
Part 2

WORKBOOK

CALIFORNIA STATE DEPARTMENT OF EDUCATION
MAX RAFFERTY-Superintendent of Public Instruction
Sacramento 1967

VT 02795

Related Training Record

A column labeled "Assignment Date" has been provided at the right-hand side of each page in the Contents. Whenever your instructor assigns a topic, he should write this date in the appropriate blank. When you have completed the topic satisfactorily, your instructor should place his initials next to the assignment date. If this procedure has been followed, and you should transfer from one school to another, you will have an accurate record of the work you have completed. It should never be necessary for you to duplicate work on topics already studied or to skip topics not previously assigned.

In order to provide other school records needed, be sure to fill in below your name, home address, and telephone number. Then ask your instructor to fill in the official date of your enrollment in his class and to sign his name.

NAME ______________________________

ADDRESS ______________________________

______________ PHONE ______________

DATE ENROLLED ______________________________

INSTRUCTOR(S) ______________________________

____

DO NOT FILM THIS PAGE

M E M O R A N D U M

TO: The ERIC Clearinghouse on Vocational and Technical Education
The Ohio State University
980 Kinnear Road
Columbus, Ohio 43212

FROM: (Person) Wallace Theilmann (Agency) California State Dept. of Ed.

(Address) 721 Capitol Mall, Sacramento, California 95814

DATE: June 22, 1967

RE: (Author, Title, Publisher, Date) ROOFING, Part 2, workbook, 1967 edition.
Prepared under the direction of the Bureau of Industrial Education
California State Department of Education

Supplementary Information on Instructional Material

Provide information below which is not included in the publication. Mark N/A in each blank for which information is not available or not applicable. Mark P when information is included in the publication. See reverse side for further instructions.

(1) Source of Available Copies:
Agency California State Department of Education
Address 721 Capitol Mall, Sacramento, California 95814
Limitation on Available Copies N/A Price/Unit workbook/$2.50
(quantity prices) SAME

(2) Means Used to Develop Material:
Development Group State Educational Advisory Committees
Level of Group Top representatives from management and labor groups
Method of Design, Testing, and Trial Course consists of a workbook for the apprentice and testbooks and final examinations for the instructor's use

(3) Utilization of Material:
Appropriate School Setting Junior College or Technical Institute
Type of Program Apprenticeship
Occupational Focus Related technical phase of the apprenticeship training program.
Geographic Adaptability N/A
Uses of Material Classroom instruction (individual and class front)
Users of Material Indentured apprentices

(4) Requirements for Using Material:
Teacher Competency Qualified journeyman from the trade
Student Selection Criteria Indentured apprentice
Time Allotment 144 hours minimum
Supplemental Media --
Necessary XXX)
Desirable ____) (Check Which)
Describe Reference books are listed in the back of each workbook.
Source (agency)
(address)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

ROOFING

Part 2

WORKBOOK

Prepared Under the Direction of the
BUREAU OF INDUSTRIAL EDUCATION

RICHARD S. NELSON
Chief of Bureau

WALLACE THEILMANN
Supervisor of Instructional Materials

"PERMISSION TO REPRODUCE THIS
COPYRIGHTED MATERIAL HAS BEEN GRANTED
BY CALIF. STATE DEPT. OF
EDUCATION
TO ERIC AND ORGANIZATIONS OPERATING
UNDER AGREEMENTS WITH THE U.S. OFFICE OF
EDUCATION. FURTHER REPRODUCTION OUTSIDE
THE ERIC SYSTEM REQUIRES PERMISSION OF
THE COPYRIGHT OWNER."

Copyright, 1967
by
California State Department of Education

Foreword

The apprenticeship programs offered in California are important phases of the total educational program for which the state is so well known. They are also unique phases of the total program, for they offer each participant opportunity to profit from paralleled and closely related learning experiences. One of these is to learn by actually working at one's chosen vocation under the direction and supervision of men who are both trained and experienced in the vocation. The other is to learn by attending classes in which all instruction is directed toward helping one to acquire the information and understanding he needs to perform on the job intelligently and with increasing proficiency and success.

The California State Department of Education has the responsibility for developing and making available the instructional materials that are used in the related training classes. It meets this responsibility primarily through the Bureau of Industrial Education.

Every effort is being made to produce instructional materials that are appropriate and adequate. These materials should be helpful to instructors in conducting their classes and to students in doing the required learning.

Max Rafferty

Superintendent of Public Instruction

Preface

The Bureau of Industrial Education has responsibility for making available the apprentice related instructional materials required for use in the training programs offered by the various trade groups in the state. The Bureau meets this responsibility by working cooperatively with employer-employee groups representing each of these trades in determining what materials are needed and in developing the materials.

This edition of Roofing, Part 2, was planned under the direction of the State Educational Advisory Committee for the Roofing Trade. The membership of the committee included the following representatives of employers and employees:

Representing the Employers

Charles Ashbourne, Long Beach
James E. Magowan, Chairman, Santa Rosa
Edward D. Weyand, Sacramento
James P. Witherow, San Diego

Representing the Employees

R. E. Franklin, Sacramento
Francis McCarthy, Los Angeles
Thomas Moore, San Francisco
M. L. Van Dyke, San Diego

Material for this edition was prepared by William Woltjes, Apprentice Training Specialist, Los Angeles City Schools, assisted by John Fredricks, Francis McCarthy, Kenneth Jacobs, Richard Isaacs, and Marvin Mainer.

Special thanks and appreciation are also extended to William Finch, Oakland; L. H. Thomas, Oakland; William Phalanger, Oakland; and James Magowan, Santa Rosa, for assistance given in checking the material for technical content.

DONALD E. KITCH
Acting Chief,
Division of Instruction

RICHARD S. NELSON
Chief, Bureau of
Industrial Education

Contents

Page Assignment date
Foreword iii
Preface v

UNIT A BUILT-UP ROOFING, DAMPPROOFING, AND WATERPROOFING

Topic

1 Application of a Built-up Gravel Roof 1
2 Cutting and Folding Corners. 13
3 Insulation and its Application 27
4 Flashing 35
5 Sumps and Drains 49
6 Roofing Repairs 57
7 Dampproofing and Waterproofing. 67

UNIT B COMPOSITION SHINGLING

Topic

1 Safety on Steep Roofing 77
2 Roof Preparation 85
3 Preliminary Information on Shingling. 93
4 Application of Asphalt Shingles 97

UNIT C RIGID ROOFING

Topic

1 Tile Types, Stacking, and Loading 103
2 Tile Application 113
3 Tile Ties and Tying Methods 129
4 Asbestos Cement Shingles and Slate 137

UNIT D BLUEPRINT READING

Topic

1 Blueprints and Their Use 141
2 Roof Sketching 147
3 Lines, Symbols, Conventions, and Abbreviations 157
4 Plan Views and Elevations 165
5 Sections and Details 173
6 Roofer's Takeoff Sketch 179

UNIT E ESTIMATING

Topic

1 Types of Buildings, Roofs, and Zones 181
2 Principles of Estimating 189
3 Measuring Flat Rectangular Areas 197
4 Measuring Curved and Irregular Surfaces . . 207

		Page	Assignment date
UNIT F	EXERCISES IN ESTIMATING		
Topic			
1	Basic Information	219	______
2	Coatings	225	______
3	Materials and Methods	227	______
4	Recover Work.	229	______
5	Composition Shingles	231	______
6	Tile and Cement Asbestos	233	______
7	Foundation Waterproofing	235	______

unit
a

Built-up Roofing, Dampproofing, and Waterproofing

TOPIC 1--APPLICATION OF A BUILT-UP GRAVEL ROOF

This topic, "Application of a Built-up Gravel Roof," is planned to help you find answers to the following questions:

- On what major factors does the quality of a roof depend?
- What are the primary techniques used in the application of a built-up roof?
- Why are slip sheets used, and how are they usually applied?
- Why is the amount of exposed roofing important to planning?
- What effect does the kind and color of a roof coating have upon interior temperatures?
- What is glazing, and when is it required?

The application of built-up roofing constitutes a major portion of the work done by the roofer, and since many of the applications of such roofs are on large deck areas, much of the processing may be done by mechanized means. However, applying roofing on small deck areas by mechanized means is impractical and is therefore done by hand.

The quality of any roofing job is controlled somewhat by the materials used for the job, and these materials are usually chosen in the light of what the customer wants or can afford. However, while it is certainly true that no roofer, no matter how skilled, can do a quality roofing job while using inferior or inadequate materials, this is no reason for lessening in any way the quality of workmanship that goes into the job.

The two prime ingredients for a quality roofing job are: (1) good materials with which to work and; (2) sufficient knowledge and skill on the part of the workmen. But the catalyst that turns these ingredients into a properly performed and "finished" job is the desire of the roofer to do good work. It is best defined, perhaps, as "pride of craftsmanship," and it should be a basic part of any job, large or small.

The Built-Up Roof

Owing to the very nature of roofs, it is not practical or possible to prefabricate a roof. Every roof must be fabricated on the roof deck to be covered, and built-up roofs are made by sealing layers of roofing felt together with bitumen adhesive. Each layer of felt is called a "ply."

The type of roof and number of plies to be used on any job may be determined by the roof engineer, architect, specification writer, or the roofing contractor. Many factors influence this decision--the prevailing climate in a given area, the type of deck being covered (whether it is concrete, gypsum, wood, or steel), the pitch of the roof, and building codes. For example, the flatter a roof the more plies required: a deadflat roof usually requires a minimum of 4 plies, and roofing material manufacturers specify 4 plies over concrete and insulation, and prefer 5 plies over wood.

Roofing felts are usually applied "shingle fashion" so as not to buck water, and are either shiplapped or strapped, depending on the pitch of the roof. This applies to 15, 30, 40, or 50 lb. felt, depending on the specifications. Any roof with more than a 1" in 12" pitch will require that the felts be nailed as well as sprinkle-mopped to prevent the sheets from slipping off the deck. Heavier material is either mopped or flopped in place, but the lighter weights can either be rolled or pulled into place. Care must always be taken, however, to avoid any wrinkles in the felt, as these may later become blisters which can cause a roof failure.

Felts are mopped solidly together, but never to the deck. They are attached, instead, by nailing or by sprinkle-mopping and nailing. If nailed only, it must be done in such a manner that every sheet is held by the nails.

Application of a 3-Ply Gravel Roof

The construction of a built-up roof with no cap sheet specified is done as follows:

• First Operation:	Preparation of roof deck (Refer to Unit D, Topic 1, Roofing, Part 1.)
• Second Operation:	Application of insulation (Refer to Unit A, Topic 3, Roofing, Part 2.)
• Third Operation:	Application of base or dry sheet (Refer to Unit C, Topic 2, Roofing, Part 1.)

The base felt application of 3-ply may either be laid up "one and two" or straight 3-shingle fashion. When the pitch of the roof is greater than 1/4" in 12", it is better to lay up a straight 3-shingle fashion to minimize the gravel weight on the exposed portion of the felt. The reason for this is that when laid up with a base sheet (also called a dry or slip sheet), there is a 17-in. strip of exposed felt that must support the gravel; whereas with the same sheets laid up in straight 3-ply, the exposed portion is minimized, thereby reducing the amount of gravel weight that must be supported by nails.

Perforated felt should never be used when laid "one and two," since this is meant to be bedded. A rosin sheet is always used as a slip sheet, which also prevents asphalt from dripping between the roof deck sheathing.

Purpose of a Drysheet

The main reasons for using a drysheet are:

- To prevent the normal expansion and contraction of the deck from buckling the finished roof assembly
- To prevent the moisture from penetrating insulation materials (providing a saturated felt is used)
- To allow the roof deck to breathe, thereby preventing the formation of blisters

Disadvantages of a Drysheet

Drysheets have disadvantages, and the following are two prime examples:

- A drysheet may develop wrinkles if exposed to the weather while waiting to be covered with plies. Sprinkle-mopping prevents this condition to some extent, as does water glazing. (Note: sprinkle-mopping is permissible on any deck except 1" x 6" sheathing.)
- A drysheet, when nailed, has a tendency to tear up and blow off easily. Sprinkle-mopping helps to prevent this to some extent, but the presence of asphalt on the top of the sheet, which is hard to avoid, results in the drysheet sticking to equipment or the workmen's feet, causing holes to be torn in the sheet before the roof assembly is applied.

Application of a Roof Assembly with a Base Sheet and Two Felts

The correct procedure for applying a roof assembly with base sheet and two felts is as follows:

- Starting at the lowest, or drain, point of the roof, lay a full 36-in. base sheet and proceed up the incline, lapping 2 in. on side laps and 4 in. on end laps.
- Start the 2-ply at the low point by solid-mopping an 18-in. wide roll of felt, then solid-mopping a 36-in. area and embedding a full roll of felt. Follow this by solid-mopping the upper 19 in. of that roll, leaving 17 in. exposed (Fig. A-1).

Application of a Straight 3-Ply Roof Assembly

Safety Note: When applying felts in the following manner, care must be taken to prevent hot asphalt from dripping through cracks in the sheathing when 1" x 6" decks are being covered. It is best to keep the mop bucket or cart close to the sheet being mopped to avoid splashing the asphalt on the unprotected deck.

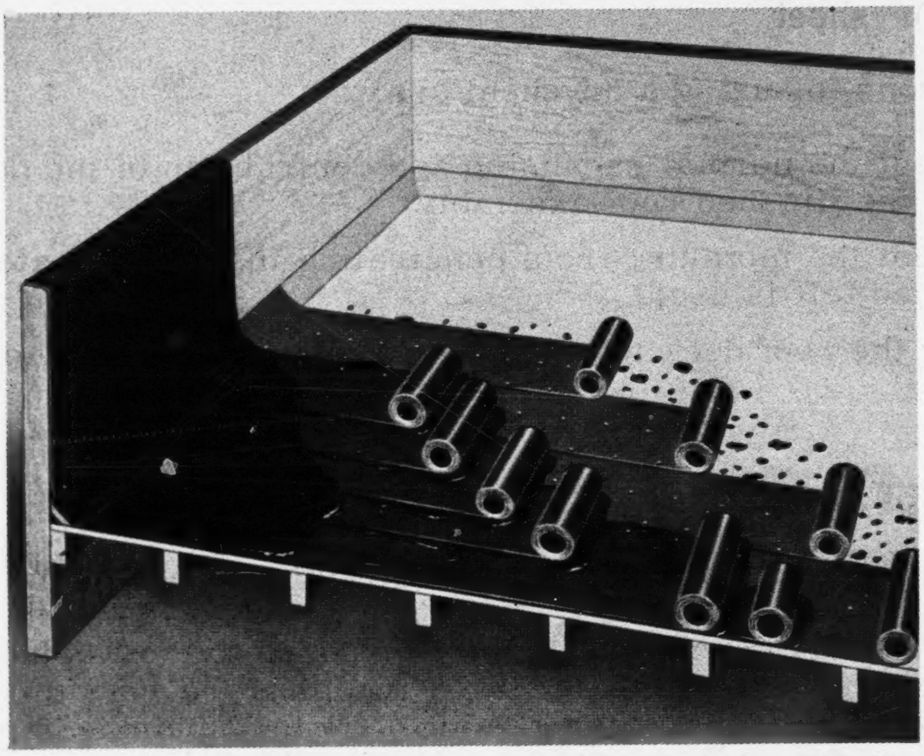


Fig. A-1. Roof assembly with base sheet and two felts

- Starting at the lowest, or drain, point of the roof, lay a 1/3 sheet of felt by nailing or sprinkle-mopping (nailing only on 1" x 6" sheathing).
- Solid mop this 1/3 sheet and embed the remaining 2/3 sheet.
- Solid mop the 2/3 sheet and embed the full sheet.
- Proceed up the incline, lapping each sheet 24-2/3 in. leaving 11-1/3 in. exposed (Fig. A-2).

A rule to remember: To find the number of inches of exposure, it is necessary to divide the number of plies into 34 in. Since 2 in. is required for a headlap (which also provides a little margin for error), only 34 in. is left to use from the full 36-in. width. For example, with a 3-ply assembly:

$$\frac{34}{3} = 11\text{-}1/3 \text{ in. exposure}$$

With a 5-ply assembly:

$$\frac{34}{5} = 6\text{-}4/5 \text{ in. exposure}$$

Application of the Gravel Surface.

For a quality application of gravel, a minimum of 40 lb. of asphalt per square is usually needed; certain roof and weather conditions may require more. (Review Unit C, Topic 2, Part 1.) An amount this large must be poured; the steeper the roof, the cooler the asphalt will have to be to keep

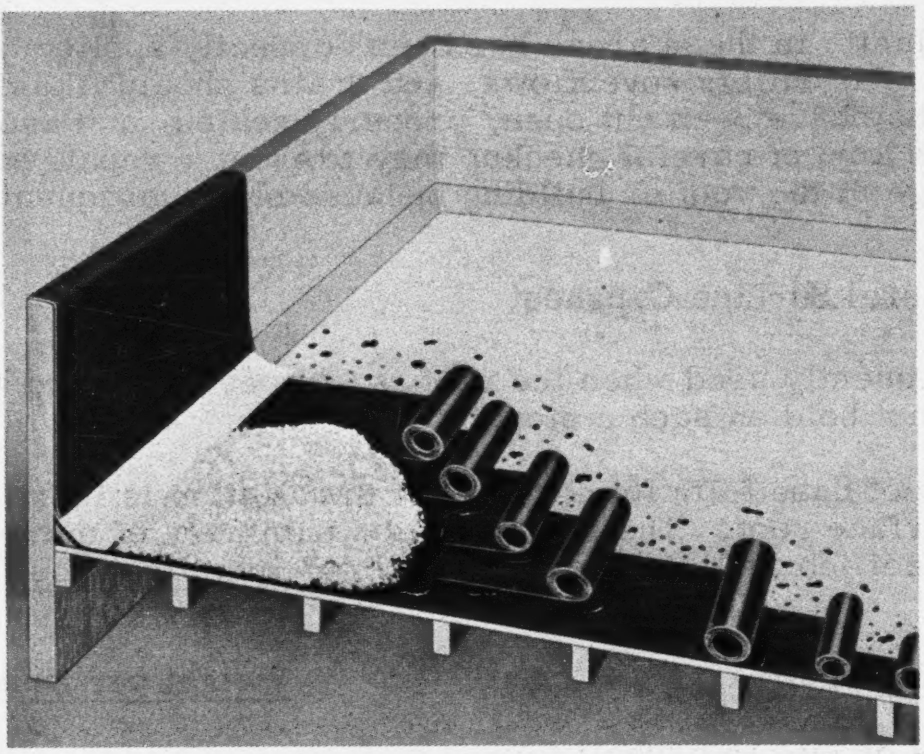


Fig. A-2. Straight 3-ply roof assembly

from running. Around gravel stops and eaves, however, the asphalt must be mopped. All hips and ridges must be double-rocked, which requires two separate applications of asphalt.

Gravel is spread immediately behind the application of hot asphalt to avoid bare spots (called "holidays"). The amount of gravel (or rock) required depends on its size and type. It must be spread evenly and smoothly and devoid of "holidays." It should also be "dolled up" as soon as possible.

It should be noted here that new developments in aggregates for roof surfacing have made possible the use of increasingly larger quantities of material with appreciably less weight, thus providing better coverage and protection without danger of roof structure failure. This is especially important where double-graveling is necessary for a more durable roof. In double-graveling, asphalt is poured over the first layer of aggregate, and a second layer is then applied.

Cleanup

The roofer is responsible for cleaning up all excess material, debris, gravel, and so forth on the roof as well as the grounds and walks in the surrounding area.

Checkup

While in the process of cleaning up, it is good practice to inspect the finished job carefully, especially at pipes, curves, and flashings to make sure that the plastic in these areas has been correctly applied and that there are no breaks. All outlets, overflows, and drains should likewise be inspected to make sure they have been cut open, properly sealed, and are free of any blockage. This kind of careful checkup may prevent a repair call later on or water damage to the roof or building because of a subsequent failure.

Applying a Mineral Surface Capsheet

Capsheet is frequently used when the roof is steeper than 3" in 12", as gravel will generally not hold on such a slope.

The application of base felts for a capsheet installation is identical to that for a gravel surface roof. The following is a summary of materials used on a typical capsheet job as listed in Built-Up Roof Specifications (Pioneer-Flintkote):

Materials	Weight per Square
2 layers of No. 15 asphalt felt (perforated felts may be used)	30 lb.
Roof asphalt	50 lb.
1 layer of 90-lb. mineral capsheet	90 lb.
Approximate total weight	170 lb.

The mineral surface capsheet on a roof is the exposed sheet. A very important step in laying mineral surface roofing is to allow the rolls of capsheet to stretch, since they are rolled and wrapped tightly at the factory. If they are not stretched prior to laying, they will stretch afterwards, causing buckles and bows. Stretching can be accomplished by stock-piling 36-ft. lengths of capsheet on the high point of the roof, keeping the granule side down and the roll ends even. They may then be cut into the desired lengths and brought down into place ready for flopping. Stretching by this method takes only a few minutes, especially in hot weather.

There are many different ways to lay out a capsheet roof, but it should always be done neatly with all end laps staggered by at least 2 ft. and header sheets installed around all edges. Capsheet should always be laid so that none of the sheets will buck water.

One method of application is to "stairstep," or "stepback," as follows: (Fig. A-3)

- Lay the sheets in sequence, starting with an 18-ft. sheet, followed by a 14-ft., a 12-ft., and so on.
- Bypass pipes 4 in. and bring the next sheet to the pipe, covering the cut.
- Place all pipe jacks, vents, and the like as the material is being laid.

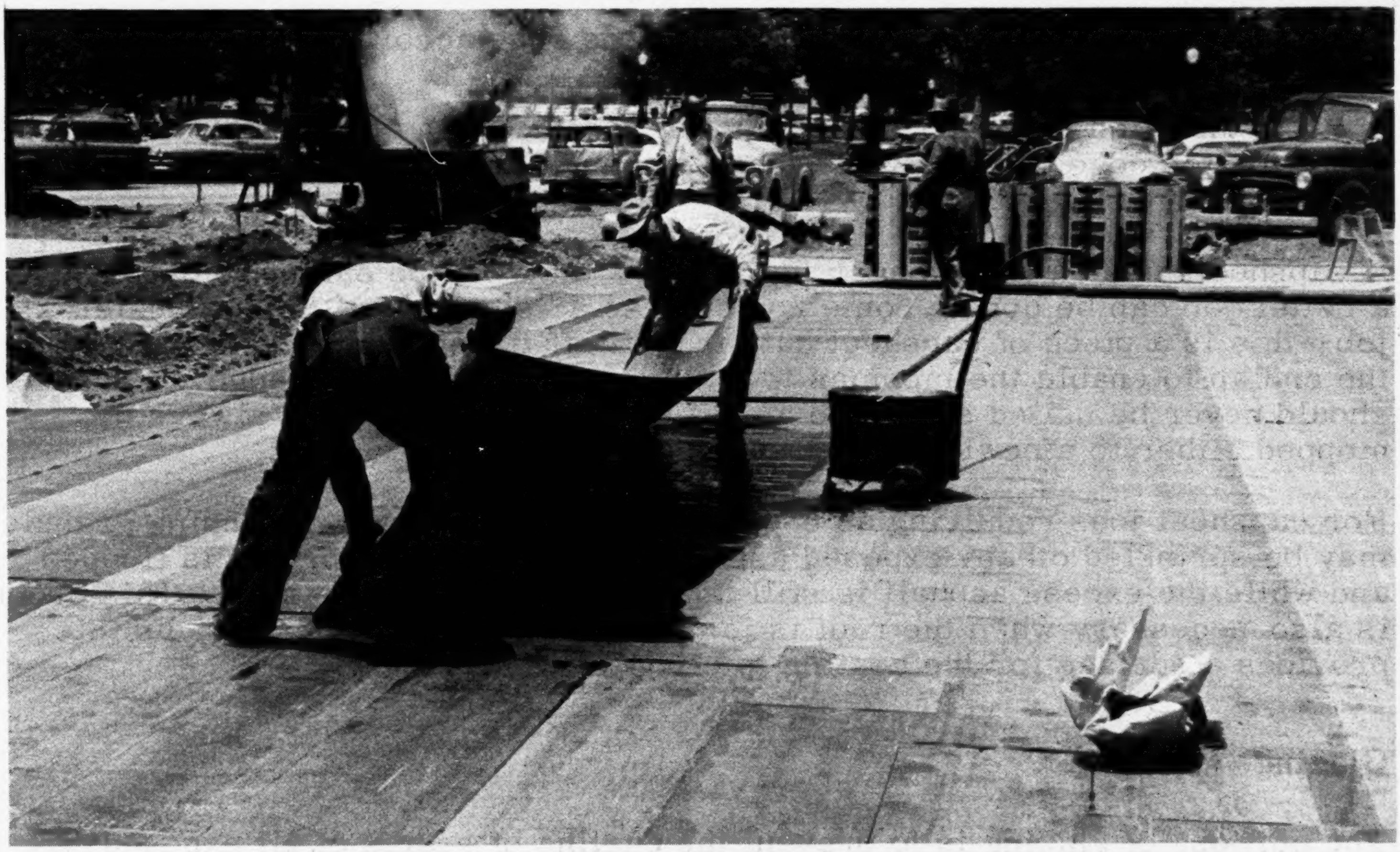


Fig. A-3. Stairstep, or "stepback," method of applying capsheet

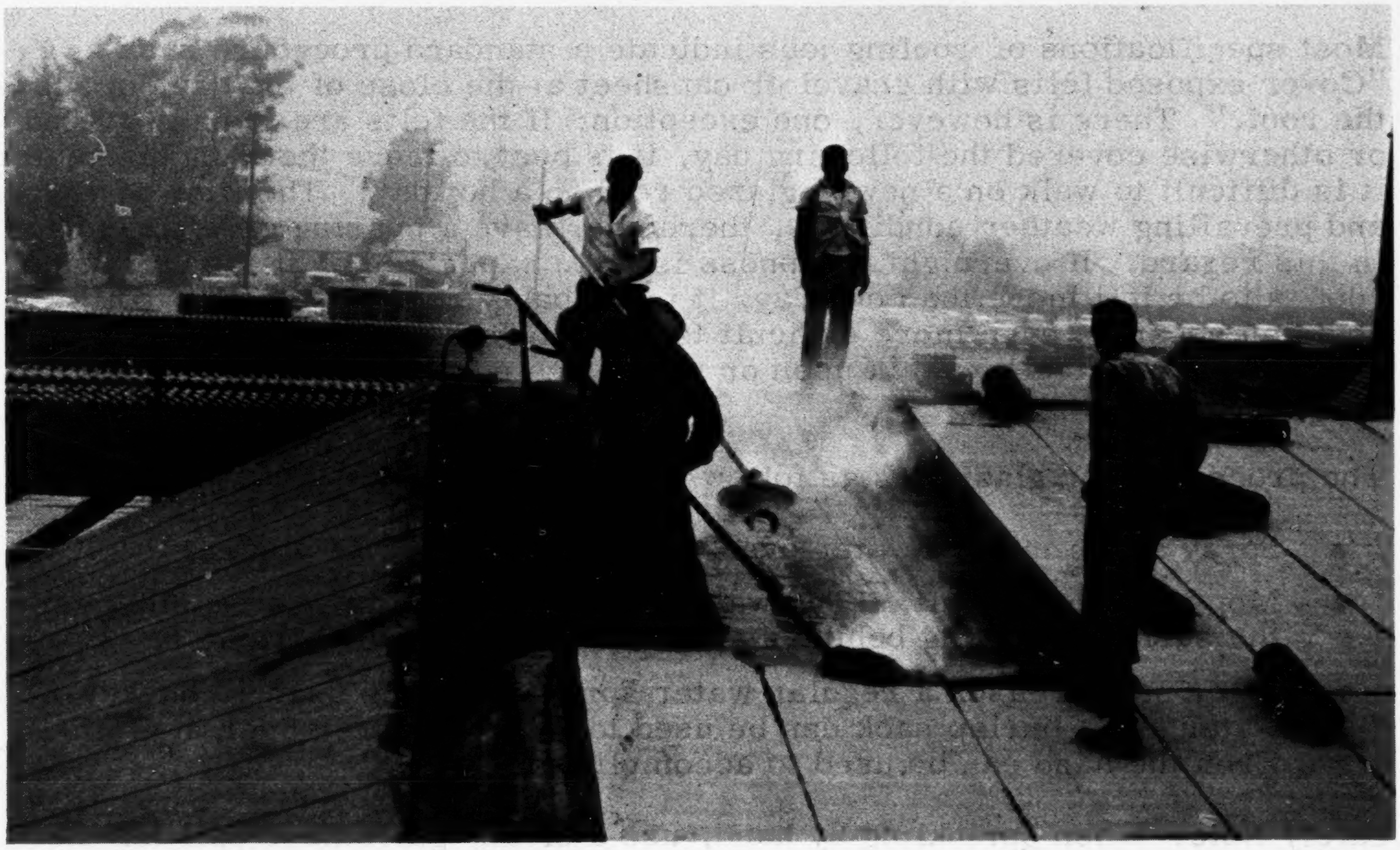


Fig. A-4. Capsheet is laid vertically when roof is steep

- If the roof has a pitch, nail the selvage edge according to the specifications for the job.
- If the pitch of the roof is steep, the capsheet may be laid vertically with the top edge nailed 6 to 8 inches on center about 3 inches down from the top edge (Fig. A-4).

If capsheets used are no longer than 18 ft., they will be easier to handle and a better job can be done. Some roofers use a "slop" sheet to do a neater job--this is a piece of capsheet cut straight off the end of the roll and laid at the endlap to enable the mopman to maintain a straight, neat edge. Capsheets should never be nailed solidly to an old roof deck; they should always be mopped either to a newly-applied or a nailed-down base sheet.

For capsheet jobs requiring an especially neat appearance, matching granules may be sprinkled on any exposed asphalt as soon as the capsheet is flopped and while the excess asphalt is still hot enough to allow adhesion. This process is also necessary when the roof is to receive a protective coating, as this provides a surface for the coating to cling to.

Glazing

The purpose of glazing is to prevent the curling of seams of all exposed felt when it is necessary to leave them overnight, over weekends, or during work stoppages.

Most specifications of roofing jobs indicate a standard procedure such as: "Cover exposed felts with gravel or capsheet at the close of the day, or glaze the roof." There is however, one exception: If the felts are to be graveled or otherwise covered the following day, it is best to leave them unglazed, for it is difficult to walk on a newly-glazed roof on a hot day. The time of year and prevailing weather conditions, therefore, have a bearing on what is done in this regard. If overnight dampness is to be expected, or if the unfinished roof is to be left more than one day, it is probably best to glaze it. This decision becomes even more difficult to make if low-melt asphalt is used, because it is difficult to walk upon or push wheeled equipment over it without tearing up the felts.

The procedure for glazing is as follows:

- Spray a fine mist of water over the exposed felt to be glazed.
- Mop with hot asphalt. (The water allows the mop to slide easily over the surface, leaving behind a very thin coating of asphalt.)
- If for some reason a regular water spray cannot be used, a bucket of water and a burlap sack can be used to sprinkle water over the felt. Even the hand can be used to accomplish this.

Safety Note: When sprinkling by hand, use a clean, galvanized pail for the water. A pail previously used for hot asphalt will make the water take on the appearance of "hot", and it has been known that a roofer, in the process of sprinkling, picked up a bucket of hot asphalt by mistake, suffering severe burns as a result.

Topcoating

In those areas of the country where the weather is not severe on roof surfaces, only topcoating is done. This consists of about a 40-lb. solid mopping. In normally cold country, the resultant "black" roof absorbs heat from the sun and actually helps warm the building. It also acts to melt snow at a rapid rate, since heat from the building escapes through the roof. The initial cost of the roofing is reduced because no expensive capsheet is applied.

Reflective coatings of aluminum are sometimes used on roofs in hot climates. It is especially important that perfect coverage be achieved in these cases without any "holidays." Maintenance cost is reduced and roof life expanded by periodic recoatings.

Topcoating should be done over sheets of 40 lb. and heavier, except lightweight asbestos sheets and glass, as these form a durable base. These sheets will actually last longer without recoating, whereas 15-lb. and 30-lb. regular felts will deteriorate rapidly after the coating dissipates.

Recovering With Built-up Roofing

Generally speaking, all factors pertaining to the application of gravel and capsheet roofs on new decks applies equally to recover jobs. There are, however, two special considerations:

- Preparation is probably the most important single item on a recover job. (Review "Preparation of the old Deck," Unit D, Topic 2, Roofing, Part 1.)
- Selection of the proper job specifications and skillful application over old material is vital to the job. (Review "Nails and Nailing," Unit C, Topic 1, Roofing, Part 1, and "Flashings," Unit A, Topic 4, Roofing, Part 2.)

Study Assignment

1. James McCawley, Roofing: Estimating - Applying - Repairing. Chicago: Shelter Publications, 1959, pp. 14-18, 130-33, and 143.

2. J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products. New York: Asphalt Roofing Industry Bureau, 1964, pp. 66-79.

UNIT A--BUILT-UP ROOFING, DAMPPROOFING, AND WATERPROOFING

TOPIC 1--APPLICATION OF A BUILT-UP GRAVEL ROOF

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	Mechanization of the roofing industry is largely due to the abundance of residential jobs.	1.	T F
2.	The small roofing job requires relatively more hand skill.	2.	T F
3.	The quality of workmanship is determined by what the customer can afford.	3.	T F
4.	The skill required to do a quality job of built-up roofing can be learned in a few months.	4.	T F
5.	Each built-up roof must be fabricated on the roof deck largely because of the very nature of the work.	5.	T F
6.	The pitch of the roof has little or no effect on the direction the roofing is laid (shiplapped or strapped).	6.	T F
7.	Heavy roofing felts should be solid-mopped to wood decks.	7.	T F
8.	Sprinkle-mopping is a technique that can be used to fasten roofing felts to the roof deck.	8.	T F
9.	When sprinkle-mopping and nailing are both used, sheets may be laid to "buck" water.	9.	T F
10.	The shape of the roof does not have a bearing on whether a 3-ply roof is laid "one and two" or straight 3-ply.	10.	T F
11.	The drysheet separates the roofing from the roof deck, which reduces problems created by expansion and contraction.	11.	T F
12.	The exposure area of the roofing felts can be determined by dividing 36 by the number of plies.	12.	T F

13. If a 20-lb. mopping is required between plies, 14-lb. will be acceptable. 13. T F

14. The gravel surfacing for a built-up roof should be applied immediately behind the asphalt flood coat. 14. T F

15. The main purpose of a gravel surface is to add color. 15. T F

16. A mineral surface capsheet should be laid in strips as long as possible to pull the "stretch" off. 16. T F

17. A mineral surface capsheet can be applied to a roof of any pitch and still give proper service. 17. T F

18. The finished appearance of a capsheet roof is especially important. 18. T F

19. "Water glaze" is a term usually associated with shower-pan membranes. 19. T F

20. Two factors that must be considered when deciding whether or not to glaze a roof are moisture and length of exposure time. 20. T F

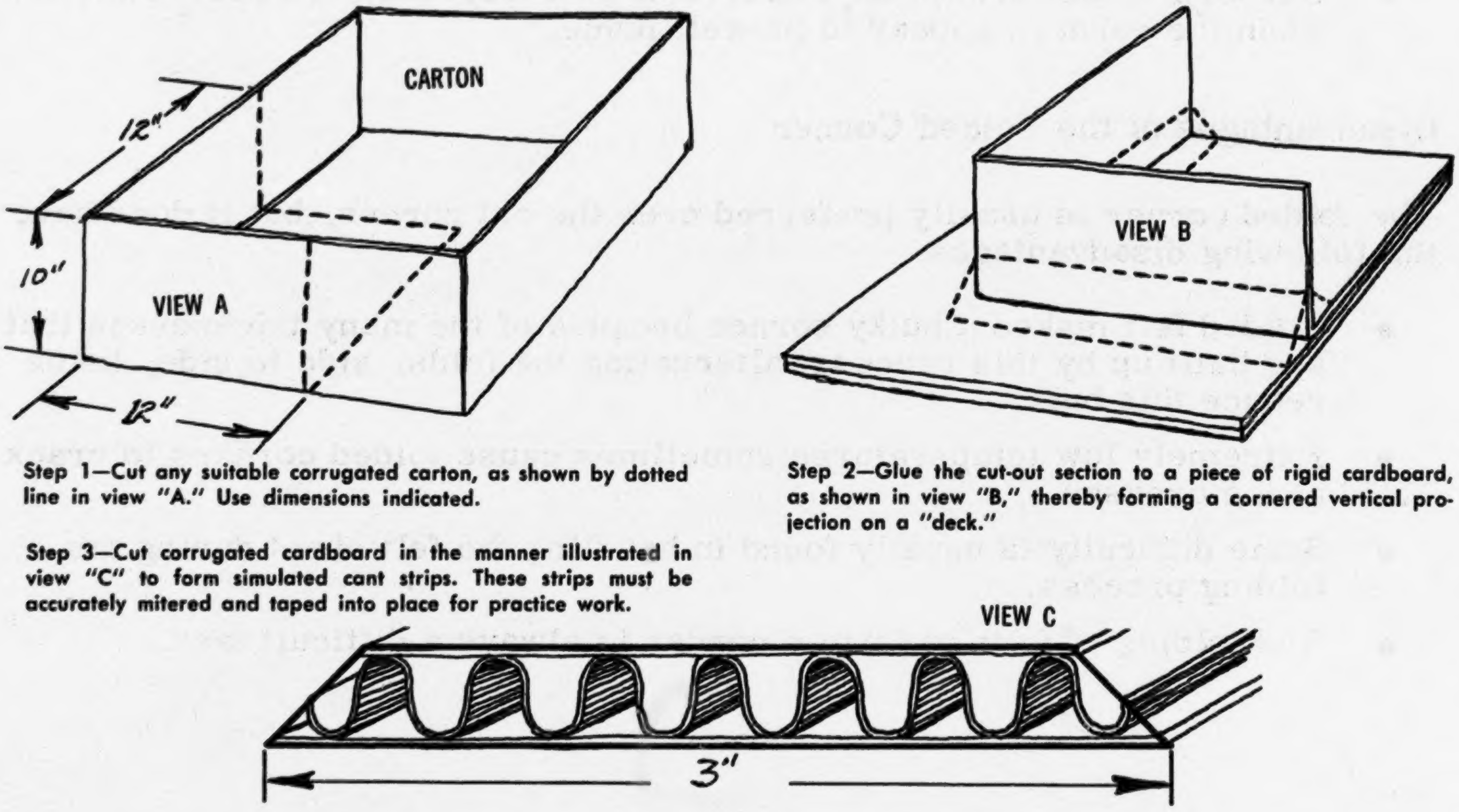
UNIT A--BUILT-UP ROOFING

TOPIC 2--CUTTING AND FOLDING CORNERS

This topic, "Cutting and Folding Corners," is planned to help you find answers to the following questions:

- **What are the procedures for cutting and folding inside corners?**
- **What are the procedures for cutting and folding outside corners?**
- **What effect does the use of cant strip have on folded corners?**
- **What special procedures are required when cutting and folding corners on stairways?**

Correctly cut and folded corners are an important part of any roofing job because, like any other phase of flashing work, this is an area where leaks are most apt to occur. The correct procedures for cutting and folding corners are outlined in this topic. The apprentice should learn these procedures by practicing them in the classroom using paper or scraps of roofing felt. In this way the apprentice should be able to cut and fold corners quickly and accurately. (A cardboard carton jig for cutting and folding corners is illustrated in Fig. A-5.)



Step 1—Cut any suitable corrugated carton, as shown by dotted line in view "A." Use dimensions indicated.

Step 2—Glue the cut-out section to a piece of rigid cardboard, as shown in view "B," thereby forming a cornered vertical projection on a "deck."

Step 3—Cut corrugated cardboard in the manner illustrated in view "C" to form simulated cant strips. These strips must be accurately mitered and taped into place for practice work.

Fig. A-5. Cardboard carton jig for practice in cutting and folding corners

The Folded Corner

The straight folded corner is the one used on most roofing jobs whenever possible. A cut corner can be made faster than one that is folded, but it requires the application of more sealer to ensure adequate waterproofing.

The following items should be given careful consideration whenever a corner is to be fabricated.

- Folding and lapping should always be done in such a way that edges do not face ("buck") the normal flow of water.
- Corners should have adequate fabric and mastic backing.
- Special care must be taken not to break or crack capsheets by creasing; this is especially important during cold weather.
- Folds and cuts should be planned so that they are in the correct location for finishing as soon as they are made. (Broken felts deteriorate very rapidly when exposed to weather.)
- The application of fibrated plastic as a sealer on both the front and back surfaces of a corner piece is considered good practice.
- Nails of adequate length must be used when securing corners. The nails must penetrate far enough into the parapet wall or other vertical surface to hold the folds securely.
- The felt used for corners should always be installed so that it is in contact with walls, cant strips, and decks at all appropriate points. This ensures a watertight job.
- Corners should always be reinforced with fabric and mastic, even when the corners appear to be well made.

Disadvantages of the Folded Corner

The folded corner is usually preferred over the cut corner, but it does have the following disadvantages:

- Folded felt makes a bulky corner because of the many thicknesses that are built up by this process; alternating the folds, side to side, helps reduce this bulk.
- Extremely low temperatures sometimes cause folded corners to crack at the creases.
- Some difficulty is usually found in handling the felt sheet during the folding process.
- The folding of felts to form a corner is always a difficult task.

Folding Inside Corners

A folded corner may be prepared as shown in Fig. A-6. When many layers of felt are required, only the last two layers should be folded; the others should be cut and butted. In this way, excessively bulky corners can be avoided.

The fabrication of a cut corner requires the greatest care since it presents many possibilities for leaking. Inside corners may be cut instead of folded, and outside corners must be cut, since there is no "surplus" material to fold.

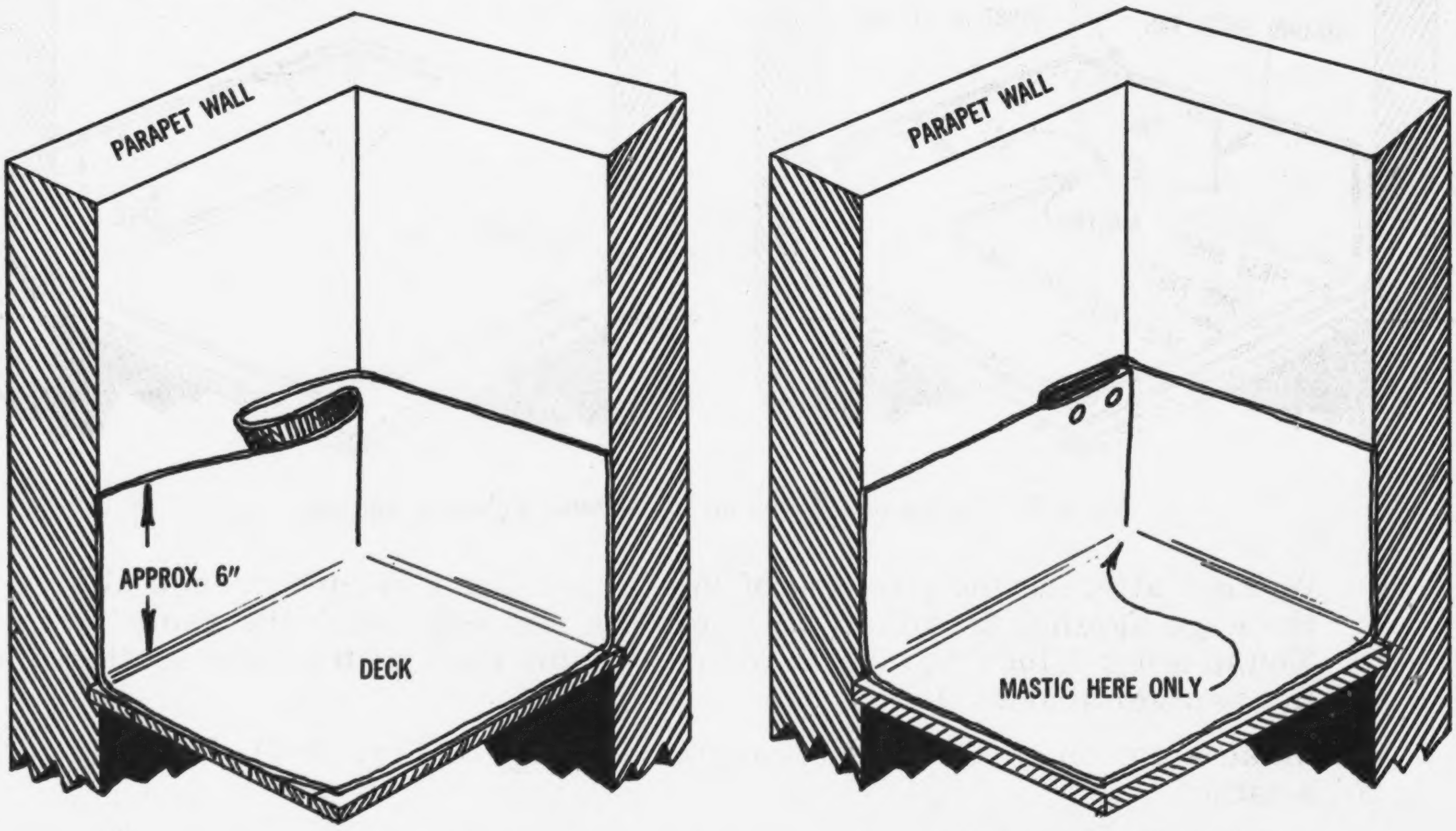


Fig. A-6. Folding an inside corner without a cant strip

Cutting and Folding Inside Corners Without Cant Strips

Two possible ways that felt can be cut to form an inside corner are shown in Fig. A-7. The recommended procedure follows:

- Lay the first sheet of felt (indicated by the dotted lines in Fig. A-7, Method "A") on the deck and turn its end up the wall 6 inches.
- Fold the felt snugly into the corner to form a right angle.
- Fold this end back against itself so the crease extends all across the felt sheet.

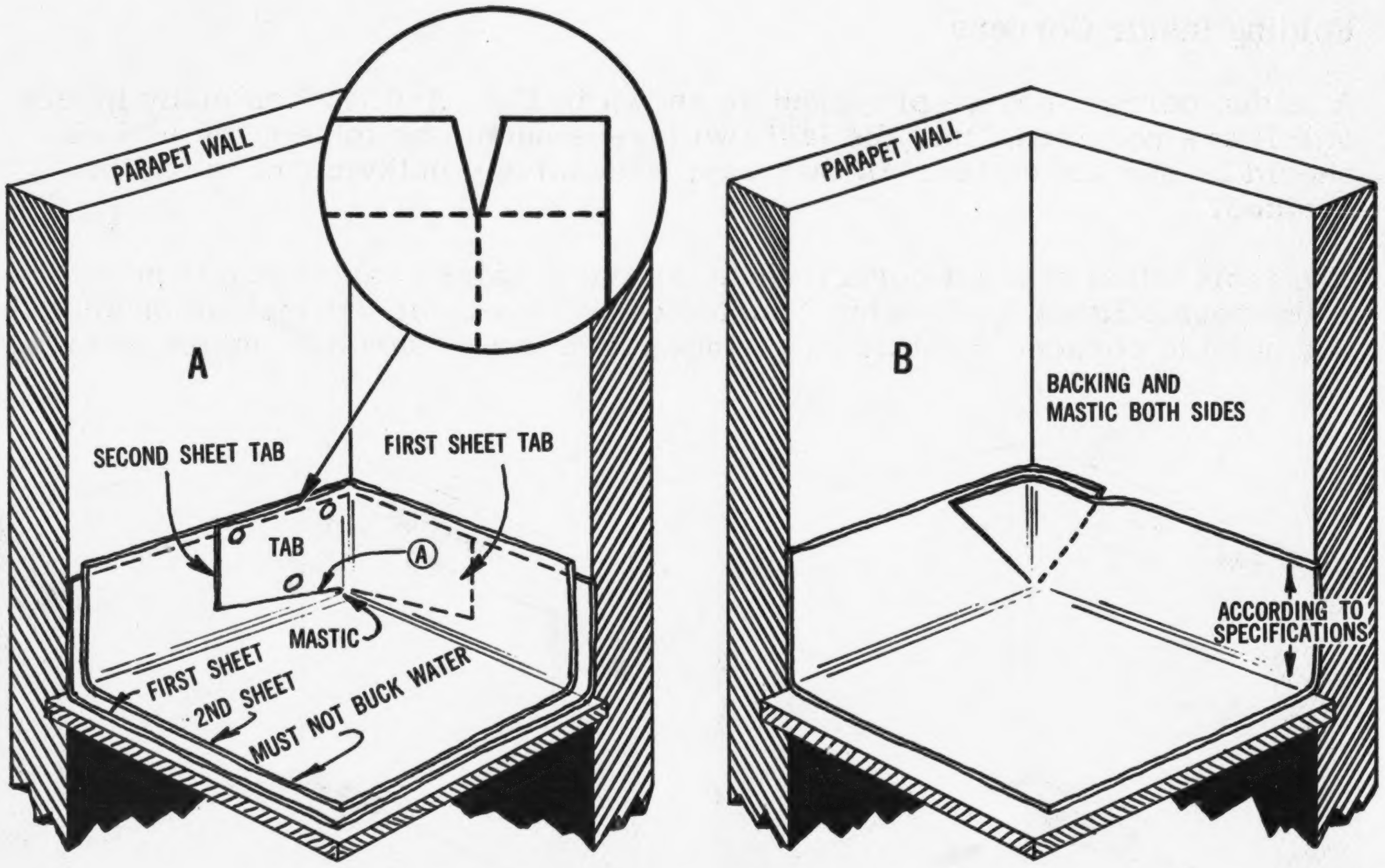

PARAPET WALL
A
SECOND SHEET TAB
FIRST SHEET TAB
TAB
Ⓐ
MASTIC
FIRST SHEET
2ND SHEET
MUST NOT BUCK WATER
PARAPET WALL
B
BACKING AND
MASTIC BOTH SIDES
ACCORDING TO
SPECIFICATIONS

Fig. A-7. Cutting and folding an inside corner without a cant strip

- Without altering the position of the felt, make a second crease along the edge against the other wall, folding this edge back the same way. Thus, a 6 x 6 inch square is formed on the deck at the intersection of the two vertical surfaces.
- Make a cut on one crease (designated by Ⓐ in Fig. A-7), forming a tab.
- Fold both ends of the felt back against the salls, treat with fabric and mastic, and nail in place. The felt tab will turn correctly to form a neat, square corner.
- Follow this same procedure with all successive layers of roofing, except that the side on which the cut is made should be alternated so that each successive tab falls on opposite walls, helping to make the corner watertight. The entire assembly may now be sealed with plastic or other flashing compound.

Another method of making this cut on an inside corner (without cant strips) is illustrated in Fig. A-7, Method "B".

Cutting and Folding Outside Corners Without Cant Strips

Cuts may be made for outside corners in much the same manner as outlined for inside corners. One method used for outside corners is shown in

Fig. A-8. The roofing material is laid in a position that will allow a 6-inch turnup at the wall. The following steps are then taken:

- Cut straight down from the top edge of the felt to the point of the outside corner at deck level (Ⓐ in Fig. A-8). Fold the end of the roofing (the tab left after the cut is made) down to the deck. (This tab will be covered with the next sheet of felt.)
- Lay the next felt on the other side of the angle in the same way, and cut from the outside edge of the sheet to the corner at deck level (Ⓑ in Fig. A-8). This cut will form a tab, or fly; bend this around the corner of the vertical surface.
- Carefully crease the felts at all angles, seal, and nail securely to the vertical surfaces.

An alternate method of cutting an outside corner is shown in Fig. A-9. An angles cut is made to form a tab, and the cuts are alternated from sheet to sheet so that the tabs will fall on opposite sides of the corner. When the final layer of felt is cut and fitted, the entire corner is sealed with mastic to make it watertight.

Cutting and Folding Inside and Outside Corners With Cant Strip

Waterproof corners depend entirely upon accuracy of layout, cutting, snugness of fit, and proper sealing with flashing compound. The sequence in which the flaps should lap over each other for inside corners is shown in Fig. A-10. Care must be taken to see that they drain over each other in shingle fashion and are nailed into place. The cutting and folding sequence used on outside corners with cant strips is illustrated in Fig. A-11. The apprentice should practice making these cuts and folds in the classroom, using the cardboard carton aid previously described and waste paper in place of roofing felts.

Stairway Membrane

The principles of cutting and folding corners apply equally to the waterproofing of an exterior stairway. The technique used to apply felts to a typical stairway is illustrated in Figs. A-12 through A-14.

Waterproofing a Stairway

Waterproofing an outdoor stairway that is to receive tile or some masonry material involves only good roofing principles. The basic procedures for the cutting and folding of corners should be followed, and the same care practiced in other phases of a roofing job is essential on stairways.

Although the covering of stairway landings involves only those procedures previously mentioned, the steps followed require a few additional considerations.

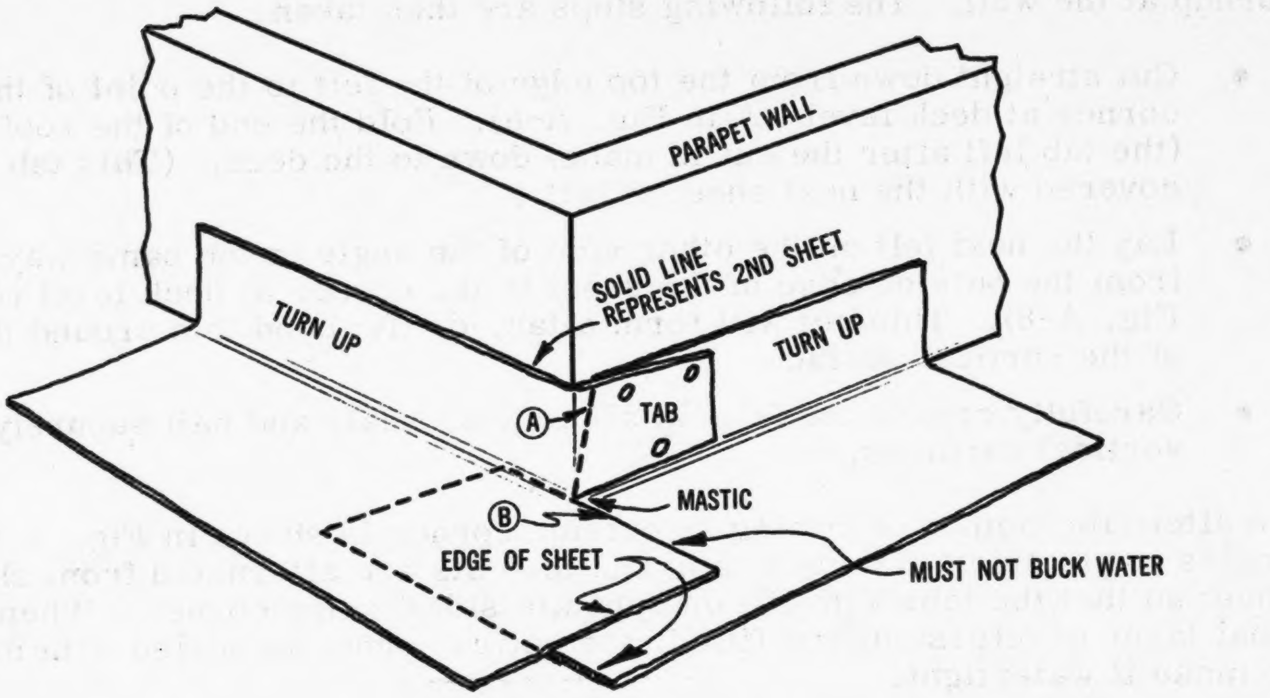

PARAPET WALL
SOLID LINE REPRESENTS 2ND SHEET
TURN UP
TURN UP
TAB
A
B
MASTIC
EDGE OF SHEET
MUST NOT BUCK WATER

Fig. A-8. Cutting an outside corner without a cant strip

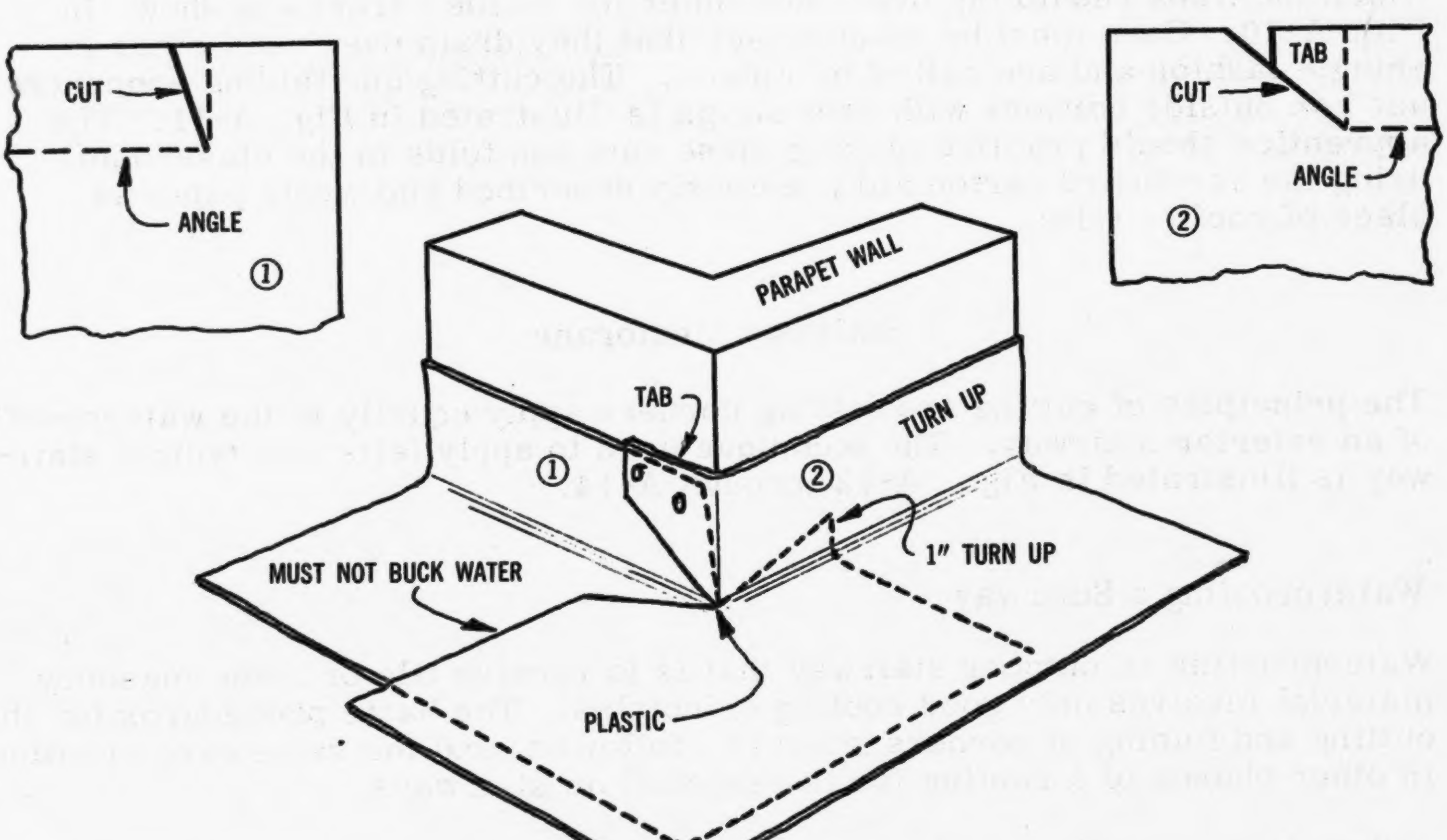

CUT
ANGLE
①
TAB
CUT
ANGLE
②
PARAPET WALL
TAB
TURN UP
①
②
1" TURN UP
MUST NOT BUCK WATER
PLASTIC

Fig. A-9. Alternate method of cutting an outside corner without a cant strip

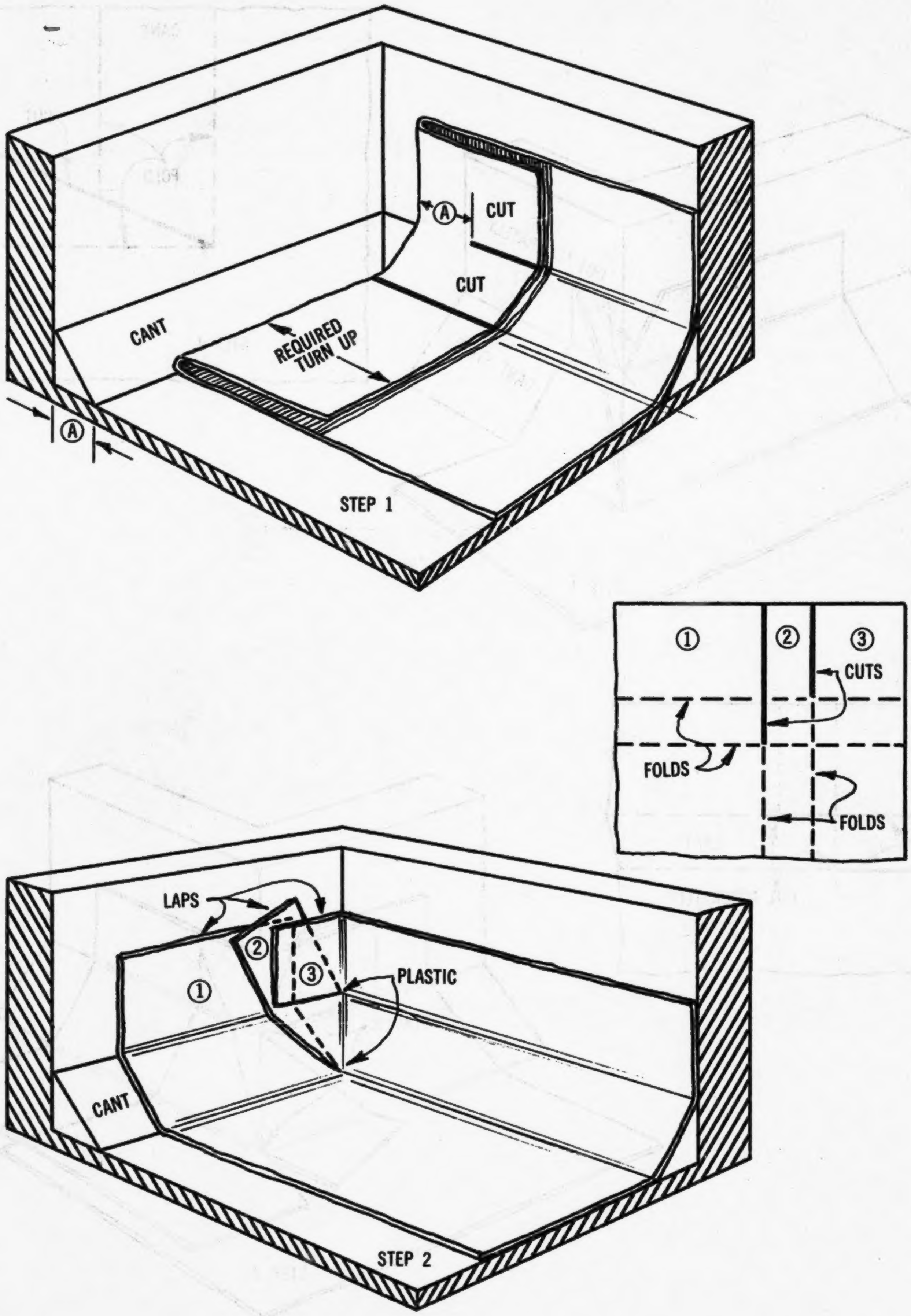

Ⓐ
CUT
CUT
CANT
REQUIRED TURN UP
Ⓐ
STEP 1
①
②
③
CUTS
FOLDS
FOLDS
LAPS
②
③
①
PLASTIC
CANT
STEP 2

Fig. A-10. Cutting and folding an inside corner with a cant strip

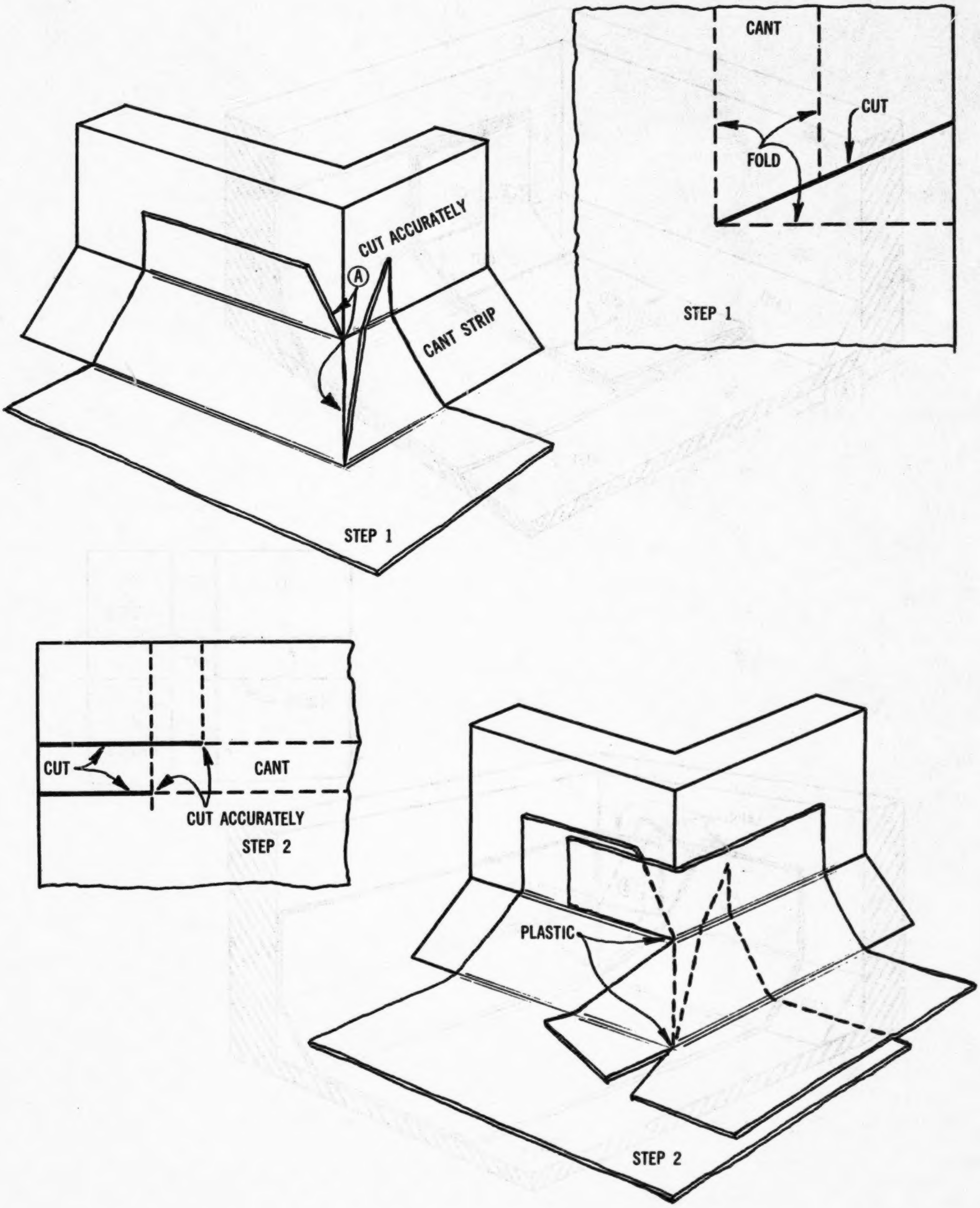

CUT ACCURATELY
Ⓐ
CANT STRIP
STEP 1
CANT
CUT
FOLD
STEP 1
CUT
CANT
CUT ACCURATELY
STEP 2
PLASTIC
STEP 2

Fig. A-11. Cutting and folding an outside corner with a cant strip

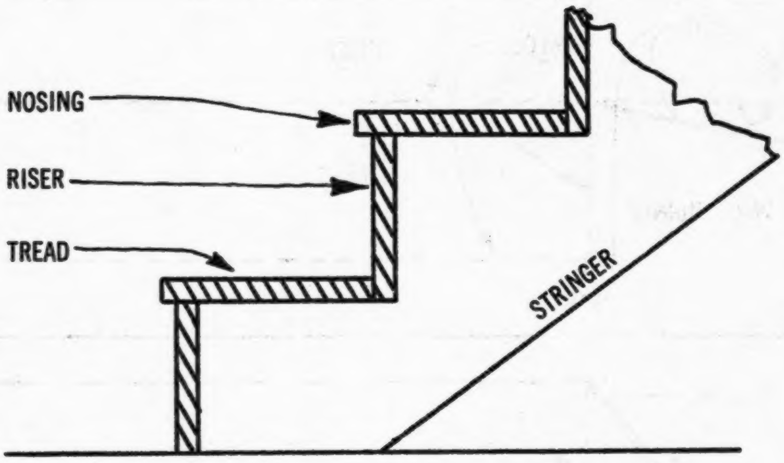


Fig. A-12. Construction of a stairway

A stairway consists of treads, risers, and landings, or platforms. (Fig. A-12). Most building codes call for minimum dimensions for stairs and stairways. While certain occupancy or design factors may require dimensions other than those considered standard, the following specifications are typical of those found in building codes, although it must be remembered the dimensions used will vary:

Stair width	30 in.
Tread width	10 1/2 in.
Riser height	7 1/4 in.

With these dimensions in mind, the roofer should compute the total length of material (cut from a roll of 15-lb. felt) in this fashion:

Stair width	30 in. (or specified width)
Overhang	4 in.
Wall turnup	4 in.
Total	38 in.

Since at least two 15-lb. felts with 25-lb. low-melt mopping are required in most cases, an added difficulty is presented in the handling of the felts when the somewhat intricate folds are made. (Note: Laps in the felt may be placed anywhere parallel with the step.)

Once a pattern is made, one roofer can cut, fold, and premop the pieces while another roofer does the installation. It is always best to make separate boxes for each step rather than lay up full sheets double, because this allows the installer more time to form the felt and fit it to the step before the asphalt hardens (Fig. A-13).

The general preparation and installation procedures are as follows (Fig. A-14):

- Measure the width of the stairway, allowing enough for overhang and wall turnup.

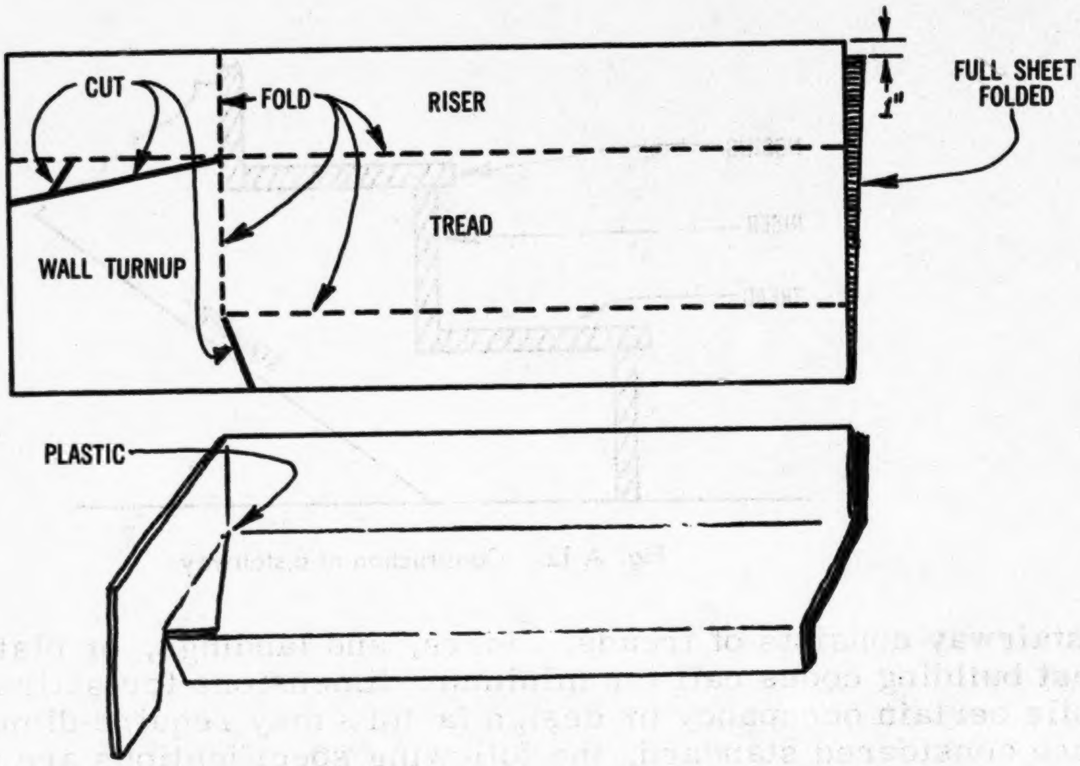

CUT
FOLD
RISER
TREAD
WALL TURNUP
1"
FULL SHEET FOLDED
PLASTIC

Fig. A-13. Cutting and folding stair felts

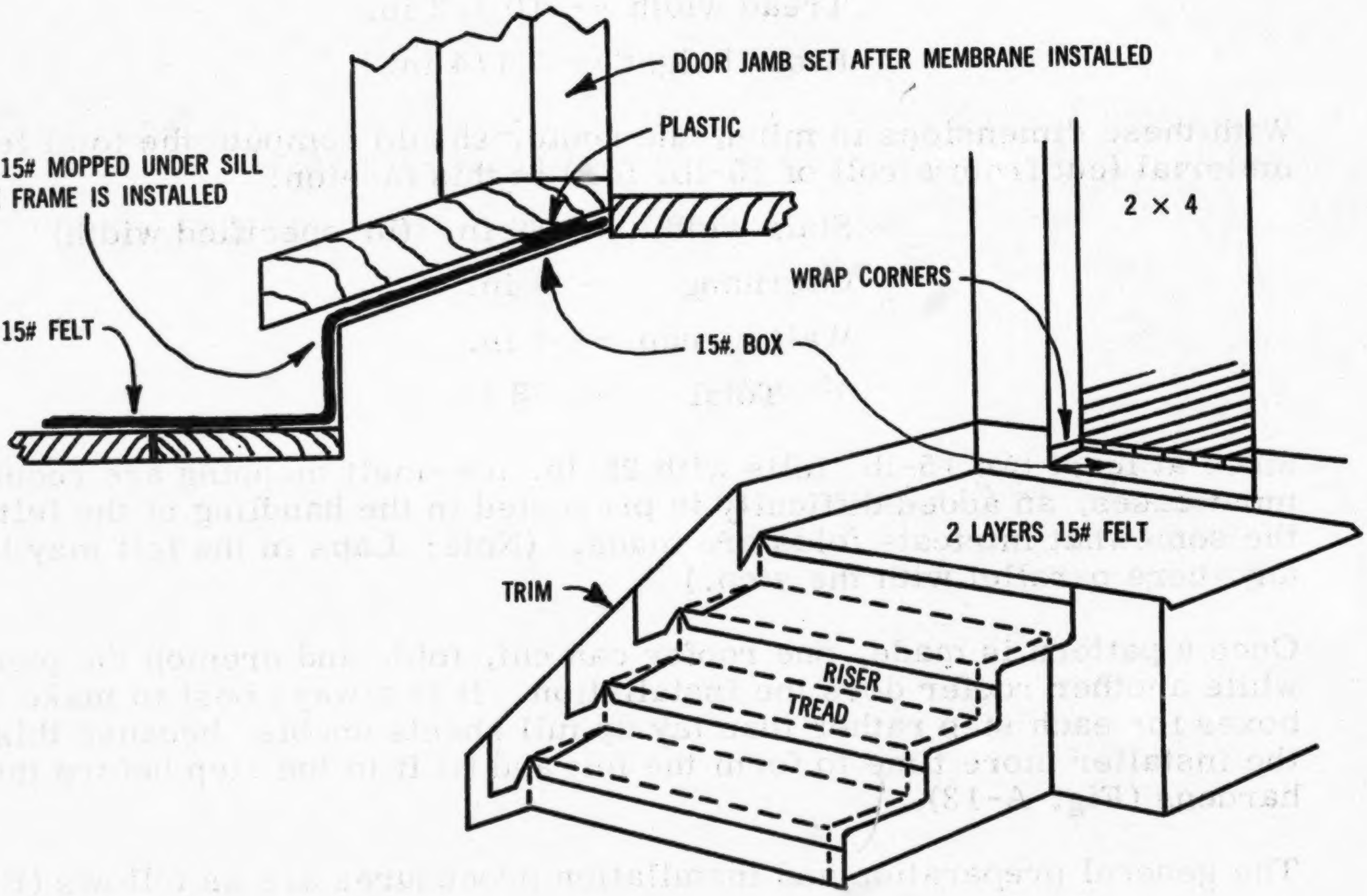

DOOR JAMB SET AFTER MEMBRANE INSTALLED
PLASTIC
2 LAYERS 15# MOPPED UNDER SILL BEFORE FRAME IS INSTALLED
2 × 4
WRAP CORNERS
2 LAYERS 15# FELT
15#. BOX
2 LAYERS 15# FELT
TRIM
RISER
TREAD

Fig. A-14. Application of stair and sill coverings

- Fold the felt lengthwise with a 2-in. overlap over the nosing end of tread.
- Complete the folding in accordance with the pattern.
- Cut, mop, and apply the felt to the first step, immediately fitting the felt snugly into place.
- Nail to stair treads and riser boards, but only over supporting stair stringers. (Do not nail where nails from subsequent layers will penetrate, as this constitutes double nailing.)
- When all the stairs and landings have been covered with the required number of layers, top-mop with low-melt asphalt and sprinkle with dry cement.

The wall turnup will be covered with paper and stucco netting or siding after the roofer completes the installation of the stair waterproofing membrane. The overhang at the end of the tread or on the open side of the stairway should be bent down over the building paper that is applied by the carpenter or lather.

The roofing membrane is placed under the doorsill before the carpenter installs the doorframe (Fig. A-14). Small pieces of felt should be placed at each end to form a box. The assembly thus formed is nailed securely in place and top-mopped.

Topics for Discussion

Be prepared to discuss the following topics if you are asked to do so:

1. What is considered the best overall method of flashing corners in our geographic area?
2. What job or weather conditions will determine whether corners are to be folded or cut?
3. What is the best (or most acceptable) method to follow in our area for making corners watertight?
4. If you were a job foreman, how would you make corners, and why?
5. Do the procedures outlined for forming corners on a roof deck apply to showerpan construction?
6. What teamwork methods should be used in applying stair membrane?
7. What safety precautions should be observed when waterproofing a stairway (specifically: hands, feet, cleanliness, and slipping)?

UNIT A--BUILT-UP ROOFING

TOPIC 2--CUTTING AND FOLDING CORNERS - Study Guide and Checkup

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) select the word that belongs in each numbered space in an exercise; and (2) write the word at the right in the space that has the same number as the space in the exercise.

1. To ensure tight corners, felts should touch all points on the ___1___ and ___2___.
   1. ________
   2. ________

2. Alternating a corner fold from ___3___ to ___4___ helps avoid excessive bulkiness.
   3. ________
   4. ________

3. A disadvantage of the cut corner is the need for additional ___5___ and ___6___.
   5. ________
   6. ________

4. On folded inside corners, no more than two layers should be folded; the remainder should be ___7___ and ___8___.
   7. ________
   8. ________

5. In nailing corners, the nails used should be of sufficient length to ___9___ the ___10___ wall.
   9. ________
   10. ________

6. When making a folded corner, the roofer must take special care to see that capsheets do not ___11___ or ___12___.
   11. ________
   12. ________

7. All lapping must be done in such a way that no edge will ___13___ ___14___.
   13. ________
   14. ________

8. It is always difficult to ___15___ corners ___16___ in place, because felts are bulky and hard to handle.
   15. ________
   16. ________

9. For the purpose of roofing procedures, it may be stated that stairways consist of ___17___, ___18___, and landings.
   17. ________
   18. ________

10. In most cases involving the waterproofing of stairways, at least ___19___ 15-lb. felts and a mopping of 25-lb. ___20___ asphalt are required.
    19. ________
    20. ________

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. When corners are made, the roofing should be turned up 4 to 6 in. on vertical walls. 1. T F

2. Cutting corners is usually the accepted procedure rather than folding. 2. T F

3. A disadvantage of folding corners is the difficulty in handling the sheet prior to folding. 3. T F

4. The same procedure is used in making cuts for both inside and outside corners. 4. T F

5. The principles of cutting and folding corners apply to stairways as well as to flat decks. 5. T F

6. A stairway consists of three basic parts: treads, risers, and steps. 6. T F

7. When an outside corner is made with a cant strip, three cuts are necessary to make a correct fit. 7. T F

8. An application of asphalt is all that is required to fasten the felt turnup to the firewall. 8. T F

9. At least three layers of felt are used in waterproofing stairways. 9. T F

10. The best method of creasing the roofing felt into the angle is to "walk it in" with the toe of the shoe. 10. T F

11. Only one man is usually required on a stairway covering job. 11. T F

12. Extremely cold weather may cause roofing material to crack in a cut corner. 12. T F

13. In waterproofing a stairway, each ply should be installed separately. 13. T F

14. When a stairway is waterproofed, the doorsill covering should be fabricated after the door frame is installed. 14. T F

15. Minimum dimensions are specified for stairs and stairways in most building codes. 15. T F

UNIT A--BUILT-UP ROOFING

TOPIC 3--INSULATION AND ITS APPLICATION

This topic, "Insulation and Its Application," is planned to help you find answers to the following questions:

- What is insulation and how does it function?
- What protection should be given insulation both while it is in storage and when it is being applied?
- What are vapor barriers, and when are they installed?
- What are breathers, and how are the locations for them determined?
- Why are water stops installed, and how are they constructed?
- What steps are required to prepare different types of roof decks for the installation of insulation, and how should insulation be installed on each type of deck?

Many different kinds of insulation have been placed on the market. Certain of these have been made possible by scientific advances. For example, glass filaments, cellular glass, spun rock, and foamed plastics are new materials produced by scientists. Certain of the different kinds of insulation have been produced by making improved uses of well known materials, such as cork, cane, and wood fiber. But regardless of the material that is used in the production of a particular kind of insulation, the basic principle in the construction of insulation is to provide a multiplicity of connecting but separately sealed cells filled with air.

The Purpose and Selection of Insulation

Roofing insulation serves more than one function: its main function is to deter the transfer of heat, either from inside the building to outside, or vice versa; but insulation also acts as a sound absorber and fire retardant.

Although the coefficient of heat transmission determines the type of insulation to use on a given roof, these calculations and determinations are not made by the roofer. His responsibility normally begins and ends with the application of the material. Nevertheless, the proficient roofer will familiarize himself with the methods and procedures used in these determinations.

Generally, the type of insulation to be used on a roof is selected by the architect or other person who is well informed regarding insulating qualities and the standards that must be met if the desired results are to be obtained.

But every roofer should know how insulation is selected and have a good knowledge of the insulating values of different materials, because he may find it necessary to make a substitution when circumstances prevent the installation of the specified insulation.

Handling and Applying Insulation

The qualities and values of most insulating materials are reduced or destroyed by the absorption of moisture. Consequently, insulation must be kept dry while in storage on the job and during installation because most types will absorb moisture readily.

Storage of Insulation

Rain, fog, and dew all pose a threat to unprotected insulation. Some types of insulation, if subjected only to overnight exposure, will curl and become unsuitable for use. Even when it is possible to use insulation that has absorbed moisture, it is never advisable to do so, because this moisture will turn into steam under the heat of the sun, causing blisters to form on the roofing felts. Blisters thus formed will usually crack in time and cause the roof to leak.

Insulation should be completely covered overnight and during rainy days with polyethylene sheeting or 15-lb. felt, and insulation should always be stacked while still in its protective paper, each wrapper broken open only as the insulation is needed.

Insulating material should never be installed so rapidly that it cannot be sealed and made watertight at the end of each work day; otherwise, moisture absorbed overnight will be sealed in by the next day's application of felt, causing trouble later on when the moisture, in the form of steam, tries to escape.

Vapor Barriers

The primary purpose of a vapor barrier is to prevent moisture in the building or roof deck from entering and damaging the insulating material. Vapor barriers are not really necessary under favorable climatic conditions, but their use is generally recommended between the roof deck and the insulation. Even under ideal conditions, lightweight cement and gypsum decks require vapor barriers, however, because decks made of these materials usually contain a great deal of moisture.

The use of correct felts, sealed with coal tar pitch or asphalt, is standard practice in building a vapor barrier. Felt, by itself, is not a vapor barrier; it must be coated and sealed.

Some noncombustible rubber- and plastic-base materials are also used as vapor barriers. These materials are applied with a compatible adhesive. (Hot asphalt cannot be used because it will usually damage the material.) The main difference between these rubber- and plastic-base materials and those made of asphalt is that they are noncumbustible, while asphalt is highly combustible.

Breathers

Venting is necessary on insulated roof decks because air trapped under the roofing felts expands in hot weather, generating steam that will cause blisters. Although edge-venting is adequate on small roofs, larger areas may require vents located in the field as well. It is usually difficult to tell where vaporization will occur under the felts; consequently, the correct number and location of breathers is virtually impossible to determine during construction. It is sometimes best, therefore, to install vents after the roof has been completed because the vapor areas will then show up, indicating where breathers are required.

Water Stops

A water stop may be applied to isolate roof areas and prevent widespread water damage from a leak caused by the puncturing of the roofing felt. Some specifications may call for water stops to be installed 2 ft. from all edges, walks, monitors, and the like, spaced no more than 30 ft. apart in all directions. Thus, with the exception of roof edges, the insulation would be completely sealed in separate 30 x 30 ft. areas. In this way, if a leak occurs, the water will be confined to an individual area and prevented from traveling between the roofing and the deck.

Usually, a 12-in. strip of 15-lb. felt is mopped with hot asphalt in a 6-in. wide strip and mopped to the deck surface or vapor barrier. The edge of the insulation should also receive a coat of asphalt (Fig. A-15). Care must be taken to make all corners square and avoid making holes in or around the water stop.

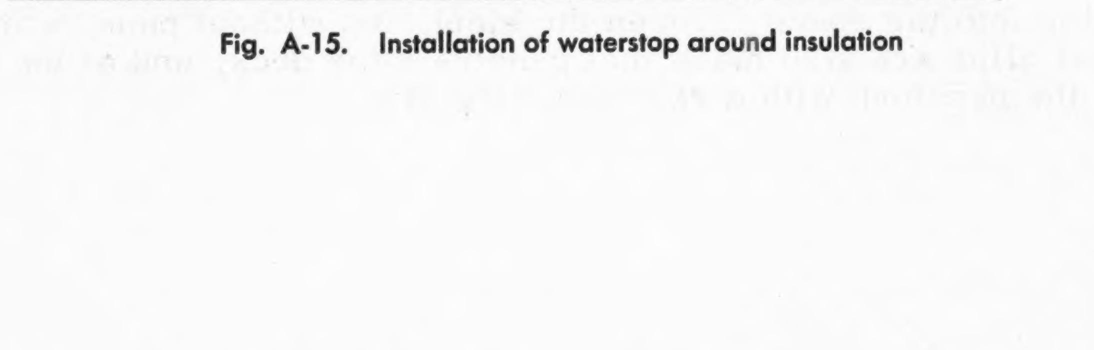

INSULATION APPLIED WITH ASPHALT
VAPOR BARRIER
WATERSTOP APPLIED WITH ASPHALT
DECK

Fig. A-15. Installation of waterstop around insulation

Application of water stops is a very time-consuming and costly process because the roofing is divided into many small sections, requiring that the insulation be interrupted every 30 ft. while the water stop felt is applied. This operation also creates extra work in cutting around walks, pipes, monitors, and the like. The time, trouble, and extra cost of this process accounts for the fact that it is seldom called for in specifications.

Fastening Insulation

There are several ways of fastening insulation to roof decks, depending upon the type of deck involved. The method to be followed is generally indicated on the blueprint or in the specifications. Following are some of the methods employed in this process:

Preparation of wooden decks. On wooden decks, insulation may be nailed or sprinkle-mopped with or without a vapor barrier. When a vapor barrier is used, the insulation may be solid-mopped only or solid-mopped and nailed. The fastening method depends upon the type of sheathing: plywood, 1 x 6, tongue-and-groove, and so forth.

The deck must be smooth, dry, well-nailed, and free from sharp projections, knotholes, and large cracks. Any such openings must be covered with sheet metal prior to applying the insulation. A 4-inch wide nailing strip with a thickness equal to that of the insulation must be installed by the building contractor at all eaves (Fig. A-16).

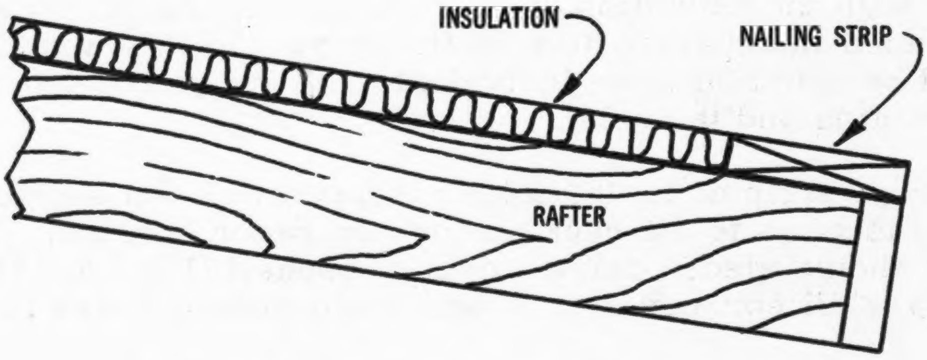


Fig. A-16. Use of nailing strip with insulation

Preparation of steel decks. Insulation may be fastened to steel decks by mopping with asphalt, nailing with steel fasteners, or applying an appropriate cold adhesive. If asphalt is to be used, the deck must first be primed. Insulation may be applied with or without a vapor barrier. When metal decks have high "ribs," the insulation should be applied so that the edges rest on the center and top of the ridges (Fig. A-17).

Several types of fasteners are available, all designed to be driven through the insulation into the space between the steel ribs without penetrating the deck. Metal clips are also made that penetrate the deck, and at the same time, seal the puncture with a self-adjusting clip.

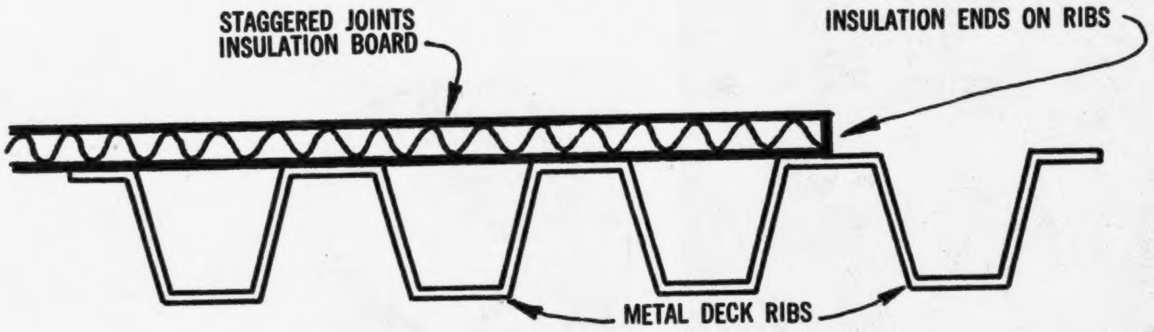


Fig. A-17. Position of insulation on a ribbed steel deck

The roofer should always refer to the specifications before starting to apply insulation on a steel deck. The deck must be clean and free from sharp projection, large cracks, and welding imperfections. Steel decks must be primed and allowed to dry completely before the loading of material or the installation process is begun.

Preparation of concrete decks. A concrete deck is prepared for the application of insulation much the same as for a wooden deck, but a few exceptions should be noted. The deck surface must be dry, clean, smooth, and free from any sharp projections and depressions. Any high spots should be chiseled down; any low spots built up. (See Unit D, Topic 1, Roofing, Part 1.)

The entire deck must be primed and allowed to become completely dry before any work is begun. Nailing strips should be installed by the building contractor as outlined for wooden decks.

Preparation of gypsum and lightweight concrete decks. The preparation of decks constructed of gypsum or lightweight concrete is the same as that for standard concrete decks, except that surface priming is not always required. A dry sheet or a vapor barrier is applied--but not solidly--to the deck.

These decks offer the most problems to the roofer. Architects and engineers are usually very deliberate in specifying the method to be used to apply insulation. The method should always include the application of one or two dry sheets (or a vapor barrier) fastened to the deck with "gyp" nails or mopped and nailed lath. If the gypsum deck has a hard dust-free finish, it can be primed and spot-mopped with no nails required to hold the base sheets.

Application of Insulating Material

Although roof deck preparation varies with the type of deck, the insulation is applied in the same manner on all decks, except for variations called for in the specifications. Two variations are shown in Fig. A-18.

- Apply insulation flush to parapet walls or nailing strips.
- Do not force insulation into place--allow sufficient space between units to permit asphalt to exude from the joints.

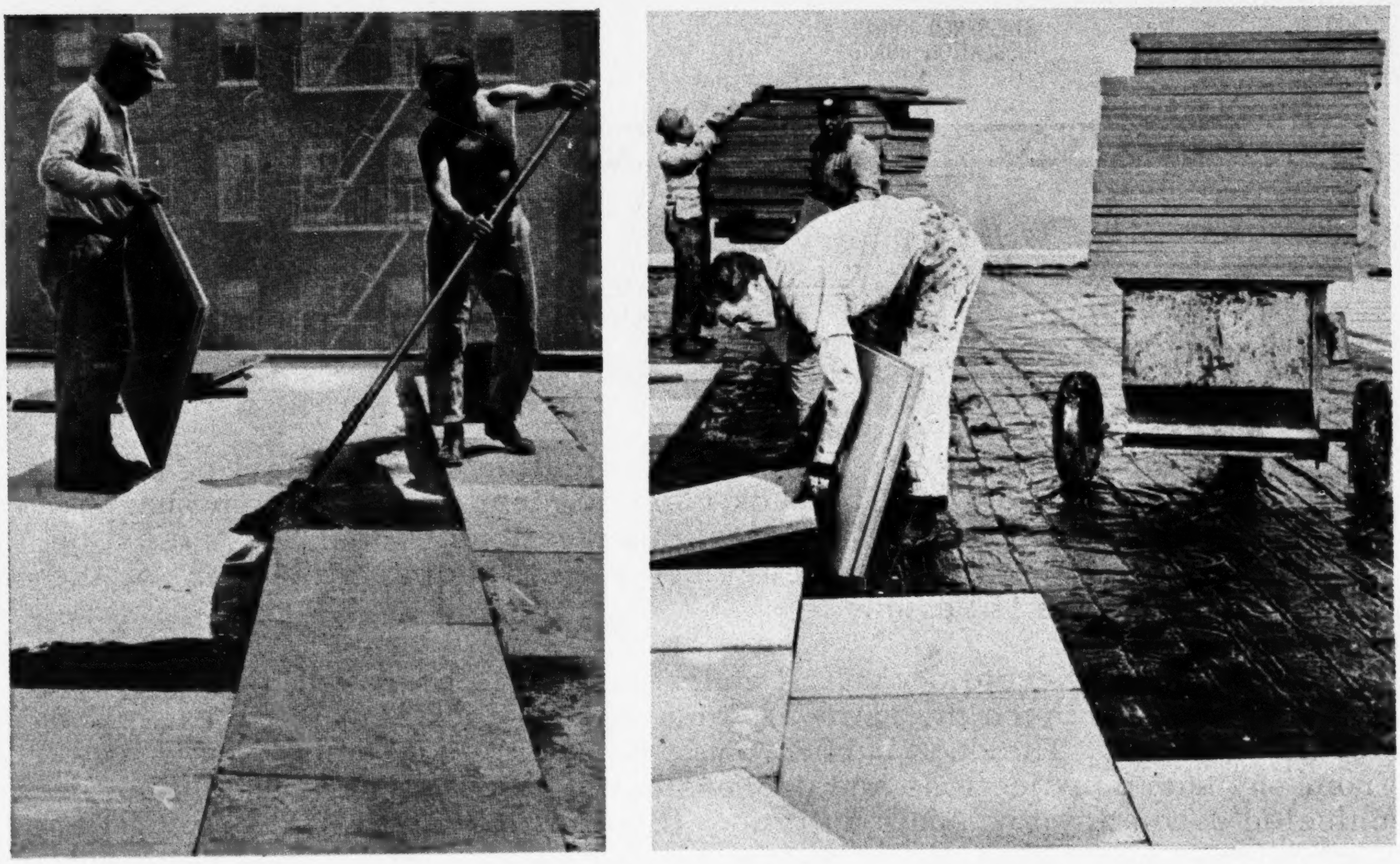


Fig. A-18. Two methods of applying insulation—hot-mopped (left) and dry (right)

- After all the insulation is installed, wrap the extended felt (see second step) back on top of the insulation and seal with hot asphalt.
- If specified, apply 4-in. cant strips of insulation or wood in all angles where the roof deck joins vertical surfaces such as walls and curbs. (If cant strips are made of insulation material, they should be mopped to the deck with hot asphalt.)
- Apply roofing felt as insulation is installed. This is essential because all installed insulation should be covered with roofing and sealed at the close of the workday. Such covering should be made with not less than one layer of 15-lb. felt, solid-mopped.

Note: Joints between sheets of insulating materials must be staggered by starting either the first or second course with a half sheet. Insulation must be applied flush to parapet walls or wood nailers.

Study Assignment

James McCawley, Roofing: Estimating-Applying-Repairing, pp. 119-129.

UNIT A--BUILT-UP ROOFING

TOPIC 3--INSULATION AND ITS APPLICATION

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Fiber insulation is so constructed that it can be left unprotected on a job site. 1. T F

2. A vapor barrier is usually recommended for use between insulation and roof deck. 2. T F

3. Lightweight cement and gypsum decks usually do not need a vapor barrier. 3. T F

4. Entrapped moisture will cause a built-up roof to blister, crack, and leak. 4. T F

5. Breathers are placed between the roofing felts and the vapor barrier. 5. T F

6. A water stop is used to attach the insulation to the deck. 6. T F

7. Water stops are time-consuming and costly to install. 7. T F

8. The insulation should always be nailed to a wooden deck. 8. T F

9. The best way to fasten insulation to a steel deck is by sprinkle-mopping. 9. T F

10. When insulation is applied to a wooden deck, the surface must be dry, smooth, well-nailed, and free of debris. 10. T F

11. Wooden decks should be primed before insulation is applied. 11. T F

12. When insulation is applied, nailing strips should be used as a guide to keep the material straight. 12. T F

13. When sheets of insulation are imbedded, they should be forced against each other to make a tight fit. 13. T F

14. Cant strips of insulation material should be mopped to the roof deck with hot asphalt. 14. T F

15. Installed insulation must be covered and sealed at the end of each day. 15. T F

16. Vapor barriers are not necessary on concrete decks. 16. T F

17. Staggering the joints of insulation is necessary only when application is made over steel-ribbed decks. 17. T F

18. The type of insulation material to be used on a roof is usually specified by the architect. 18. T F

19. Roofing insulation should always be covered when it is stored in the open. 19. T F

20. Roof breathers are installed only on the edges of a deck to permit the escape of moisture. 20. T F

UNIT A--BUILT-UP ROOFING

TOPIC 4--FLASHING

This topic, "Flashing," is planned to help you find answers to the following questions:

- How many types of flashing are used in roofing, and how are they used?
- What factors must be considered when flashing materials are selected?
- What purpose does flashing serve in the joining of new and old roofs?
- How do building codes and local ordinances relate to flashing work?
- What is a "flexible" flashing, and when does its use become necessary?

Flashing is used to seal off a roof at termination points or provide drainage at those points where the roof meets various structural parts of a building (usually vertical structures) and to prevent the intrusion of moisture at all such points. The proper selection, cutting, and application of flashing materials is one of the main skills a roofer must learn. Incorrect flashing accounts for most roof leaks today, and selection of the proper flashing for a job can prove to be most economical both for the client and the contractor.

Only minimal flashing is usually called for in competitive work. When quality flashing is required, the roofer must be familiar with all the materials and the principles of application of those materials normally used on this type of work.

Flashing Materials

Flashing material should always be suited for the conditions found in the area where it is to be used. Corrosive metals should not be used near the ocean or in factory areas where destructive fumes are present. Flashing that cannot stand extreme heat (such as around hot stacks) should be avoided where such heat is apt to be prevalent. The roofer must also avoid using flashing materials that will allow electrolytic action to occur in the presence of other, unlike metals that may be found on a roof.

Although the type of flashing material to be used on new work is generally specified by the architect, in actual practice the roofer is often forced to substitute or modify the specifications. And flashing on recover work is almost always handled entirely by the roofer, from the type of flashing used to its method of installation. Therefore, the roofer must have a thorough knowledge of flashings and how they are installed.

Certain factors must be considered when selecting flashing material:

- Geographic location
- Type of work done in the building being roofed
- Whether or not insulation is used
- Whether the roof is subject to alternate condensation and drying
- Whether the roof is subject to extreme temperature variants
- How much water is expected on the roof
- The thickness required for the metal used in flashing
- How much galvanizing will be required
- How much flashing area is located at the drip point of wood shingle
- Whether or not the flashing will be correctly treated and painted
- How the job will be assembled
- How much organic matter will fall onto the roof

Types of Material Used for Flashing

Flashing is manufactured in finished forms or it may be fabricated on the roof of many different materials. Among the many types of materials used for flashing are:

- Galvanized iron
- Aluminum
- Sheet copper
- Lead sheet
- Asphalt felts and capsheet
- Asbestos felts and sheets
- Flexible vinyl
- Flexible neoprene
- Plastic (fiberglass impregnated with polyester or epoxy resin)
- Stainless steel (chrome and steel alloy)
- Monel metal (copper and nickel alloy)
- Terneplate (lead-coated sheet iron)
- Tile (clay and glazed)
- Asbestos fibrated plastic cement (a putty type of flashing compound applied with trowel, putty knife, or gun)

Galvanized iron. Galvanized iron is made in various thicknesses, the thickness of a sheet indicated by a gauge number; the smaller the number, the thicker the metal. The U.S. Standard gauge for sheet metal for plate ranges from No. 0000000 (equal to 1/2 in.) to No. 38 (equal to 1/160 in.) The following table lists gauges in the range from No. 16 to No. 28. The gauges most commonly encountered by the roofer are indicated by an asterisk.

Number of gauge	Approximate thickness in fractions of an inch	Approximate thickness in decimal parts of an inch
16	1-16	0.0625
17	9-160	0.0563
18	1-20	0.05
19	7-160	0.0438
20	3-80	0.0375
21	11-320	0.0344
22	1-32	0.0313
23	9-320	0.0281
24*	1-40	0.025
25*	7-320	0.0219
26*	3-160	0.0188
27	11-640	0.0172
28	1-64	0.0156

Galvanizing is accomplished by pickling (cleaning) and hot-dipping sheet steel into an alloy of zinc and tin. Galvanized iron is made in various qualities and thicknesses to meet different specifications. It is generally used for flashing only on competitive type work where the best quality flashing is not required. When working with this material, the roofer must be careful not to bend it any more than necessary because bends cause slight fractures to occur in the coating, allowing the steel to rust under normal moisture conditions. The quality of galvanized iron is difficult to determine by appearance alone; it can, however, be indicated by the following factors:

- Good quality galvanized iron will not flake or crack readily when it is bent.
- No holidays, voids, or blisters will be observable on the surface.

Purchasing the material from a reputable company will generally ensure the quality of the product.

Copper sheet. Flashing made of sheet copper is durable, providing it is not installed on or close to another dissimilar metal that will allow electrolytic action to occur. Copper flashing is frequently called for by architects not only for its inherent qualities but because the green oxide that is formed on its surface after weathering lends an aesthetic effect to certain buildings. The following table shows some of the gauges and sheet sizes available in this material. Those marked with an asterisk are most common to the roofing trade.

Stubs' gauge (nearest number)	Thickness in decimal parts of an inch	Oz. per sq. ft.	Sheets 14" x 48" weight in lbs.	Sheets 24" x 48" weight in lbs.	Sheets 30" x 60" weight in lbs.	Sheets 36" x 72" weight in lbs.	Sheets 48" x 72" weight in lbs.
26*	0.0188	14	4.08	7	10.93	15.75	21
24*	0.022	16	4.66	8	12.50	18	24
23	0.025	18	5.25	9	14.06	20.25	27
22	0.028	20	5.83	10	15.62	22.50	30
21	0.0322	24	7	12	18.75	27	36
19	0.042	32	9.33	16	25	36	48
18	0.049	40	11.66	20	31.25	45	60
16	0.0645	48	14	24	37.50	54	72
15	0.072	56	16.33	28	43.75	63	84
14	0.083	64	18.66	32	50	72	96
13	0.095	70	.....	35	55	79	105
12	0.109	81	.....	40 1/2	63	91	122

Sheet lead. Lead flashing is used extensively in high-quality roofing work. This flashing may be purchased in standard sizes and forms, but much of it is custom-welded for the specific job. Lead has long been used for flashing because of its malleability; that is, it can be stretched and molded into the desired shape by pounding with a mallet. Lead is especially advantageous for use on tile and slate roofs not only because of its plasticity but because of its lasting qualities, since both tile and slate are costly to remove and replace (Fig. A-19).

Aluminum flashing. Aluminum has been used as a flashing material in increasing quantities during recent times. It has the advantage of low cost and easy handling, but its disadvantages are many. It is highly subject to rapid deterioration by electrolysis, adversely affected by alkali and salt air, and has a high expansion coefficient, causing it to break its seals.

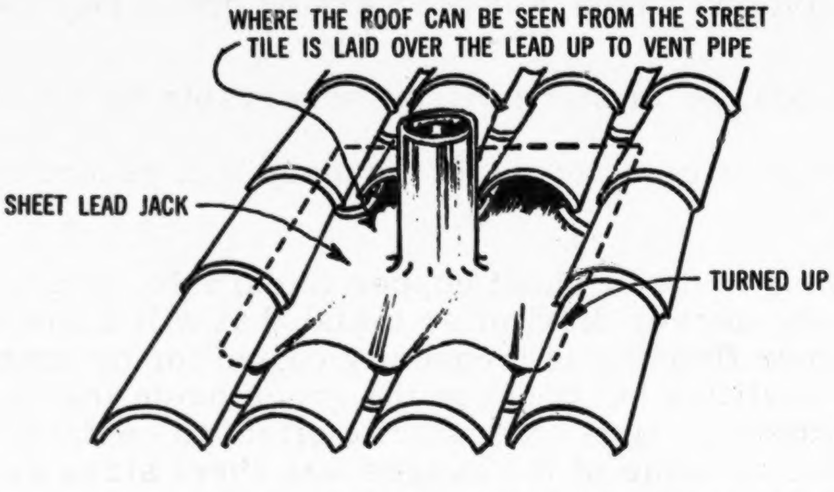

WHERE THE ROOF CAN BE SEEN FROM THE STREET
TILE IS LAID OVER THE LEAD UP TO VENT PIPE
SHEET LEAD JACK
TURNED UP

Fig. A-19. Installation of a lead pipe flashing on a tile roof

Types of Flashing

There are two general types of flashing: flashing which provides a metal flange for the roofer to "seal off" to (which may be considered "plain" flashing) and counterflashing, which is metal (or other material) used to seal off or drain water over the exposed ends of a built-up roof assembly, or metal that is part of the flashing assembly and placed at the juncture of vertical and horizontal surfaces. Counterflashing may also extend over the top of a parapet in conjunction with metal coping.

Many kinds of flashing are to be found within these two types. The following list identifies many of them by name. Following each name is a figure number which may be referred to for a pictorial representation of that kind of flashing:

<ins>Plain Flashing</ins>

Flange (F-15)
Drip or edging (F-21 to 23, 24)
Expansion joint (F-26)
Z-bar (A-21)
Channel (F-32)
Jack (A-20)
Elastic (F-37)

<ins>Counterflashing</ins>

Three and five course (F-33, 34)
Cap (F-22, 23, 24)
Coping or hood (F-7, 22, 35)
Base (F-1 thru 5; 10, 11, 33, 34)
Asbestos parapet (F-36)
Flat-to-steep (A-22, 23; F-25)
Hot stack (F-17)
Fibrated plastic (F-33, 34)
Skylight drain (F-18)
Basket drain clamp ring (F-20)

<ins>Composition shingle</ins>. The principle of flashing is to provide a series of surfaces so arranged as to shed water upon each other just as shingles do. This holds just as true in composition shingling as with any other type of roofing, whether metal, asphalt, paper, or plastic. Any surface that bucks or scoops water is not properly flashed; it is, therefore, not properly roofed.

An important factor to consider when flashing any roof is the ease with which reroofing can be done; this is especially true of a shingle roof. A superior method to follow for a quality job is shown in Fig. A-20 (B).

Care should be taken in the construction and installation of metal to provide a shape to drain water the natural way. For example, when lifting the Z-bar for reroofing, the roofer must make certain that the slope is not reversed, thus forming a trap for water.

The installation of Z-bar is usually done by the carpenter or sheet metal man during the construction of a new building. It can, however, be installed by the roofer on old structures with wood siding.

When composition shingles are specified to recover old wooden shingles, proper flashing can be accomplished by applying a 90-degree turnup under the Z-bar as shown in Fig. A-20.

There are many expandable metal flashings designed to take care of most expansion problems. However, if a problem is encountered for which there is no ready-made device, any competent sheet metal shop can fabricate one to meet the condition involved.

Flexible flashings. A problem inherent in metal flashings is that they expand and contract with temperature variations, causing fractures of the asphalt or pitch to which they are bonded. The development of neoprene, vinyl, butyl, and other rubber-like substances used for flashing has eliminated this problem, provided proper installation has been made.

Since many brands of flexible flashings are now on the market, the roofer should study thoroughly the application instructions before attempting to apply any of them. The following general steps should be taken before using any of these products:

- Clean all roofing surfaces of foreign material, including oil, dust, old roofing, asphalt, and pitch.
- Check to see that the proper material has been specified and supplied.
- When preparing the compound, make precise measurements of the catalyst and resin. (Do not let these substances contact the skin, as they are both corrosive and noxious. They are also flammable--keep them away from fire, flame, and sparks.)

Fiber glass and polyester resin. The application of fiber glass and polyester resin is performed by only a few specialized workmen, since the compounding of the material is extremely sensitive to proportion, temperature, and so forth. This compound has a limited application because it lacks the strength to withstand shock and fracture. It is used mostly for edging and gutters.

Sprayed plastic and chopped fiber glass roving material, when coated on certain parts of a roof, becomes flashing, and this material can be made to become rigid or flexible. The flexible mix is sprayed on base flashing, expansion joints, and around protrusions. The roofing manufacturers specifications should always be followed in regard to embedment and plying, since these methods will vary. None of these materials should be confused with monolithic roof systems, which are entirely different.

Three-course flashing. Composed of alternate layers of fibrated plastic, three-course flashing is used in lieu of metal (or other materials) around protruding pipes where jacks have not been specified.

Base flashing. Base flashing consists of one or more membranes (asphalt-impregnated fabric) used to protect the upturned ends of a roofing assembly at a vertical wall or similar projection. This type of flashing is commonly referred to as a "kick strip."

Pipe jacks. A pipe jack is a flanged metal covering which fits snugly around a pipe to make a waterproof juncture between the pipe and the roof.

Coping. A coping is designed to prevent the intrusion of water at the top of a parapet. Coping may be fabricated from metal and installed by the roofer or a sheet metal worker. The roofer may also install tile coping, a special interlocking glazed coping tile with appropriate corner pieces, or clay barrel tile applied with cement mortar on top of the parapet. The barrel tile should be nailed as well as sealed with mortar.

Roofer-built Flashings and Installation Procedures

Application of three- and five-course flashing. Because three- and five-course flashings are hand-crafted on the job by the roofer, some principal points are outlined here as an aid to understanding the procedure:

- Clean new brick and concrete surfaces so they are free of dust, dirt, sand, dampness, and irregular spots that could serve as bond breakers.
- On recover work, chop off old flashing to leave a smooth, clean surface.
- Prime the surface with a material compatible with the fibrated plastic or other flashing compound to be used. Primer should be permitted to dry.
- Nail turnup of roofing with concrete nails and caps.
- Apply first coat of fibrated plastic or flashing compound, embed a layer of fabric (or 15-lb. perforated asbestos felt), and nail.
- Apply a second coat of compound (additional coats are required if five-course flashing is specified).
- Apply metal counterflashing if specified.

Edging. A series of edgings used in shingling and built-up roofing are shown in Figs. F-21 through F-24. While some of these are used for decorative purposes -- that is, to cover the unsightly roof edge -- they all serve the purpose of preventing water from seeping back into the wood of the roof deck. Edging should always be sealed with some plastic between the joints to prevent moisture intrusion through capillary action. The length of metal roof flashings should never exceed ten feet. This is because excessively long flashing strips will expand under heat to the point where the asphalt seal will be broken.

Application of gravel guard. The correct installation of gravel guards can do much to assure a leak-free roof and protect the supporting woodwork against rot. A standard procedure follows:

- If guard is made and installed by the sheet metal worker, no cutting will be required, as all corners will be soldered and the guard lengths tacked in place.
- Lay a 12 in. strip of 15-lb. felt over the fascia.
- Lay gravel guard straight with an application of plastic between the joints.

- In most areas, prefabricated gravel guards are stamped out in pairs, and one end is made slightly larger than the other. Consequently, start applying gravel guard from left to right so each piece will fit correctly and the bottom laps will be even.
- Nail only enough at first to hold the guard straight and firm against the deck and the fascia. Sight along the long runs before driving nails all the way to make sure they are in proper alignment.
- Apply a porous fabric and hot asphalt over the metal and on to the previously laid 15 lb. felt.
- Apply the roofing.

The foregoing procedure is only one of many methods used to install gravel guard. This method may also be used for the installation of roof jack flanges.

Installing a pipe jack on an existing shingle roof. When plumbing or heating contractors unfamilar with correct roofing and flashing practices install pipe jacks in existing shingle or flat roofs, a potential leak is invariably created. A pipe jack should be inserted into an existing roof just as if it were shingled into the roof during the initial construction. If the pipe has already been put into place, then the roof must be torn back, the jack installed, and the shingles woven back in the manner of a new roof.

Here are a few key points in the procedure to follow when installing a roof jack in an existing roof for a pipe not yet in place (Fig. A-21):

- Determine the location of the hole to be cut. (This may be done with a plumb bob.)
- Cut the hole. If the roof has a steep pitch, the hole can be made with a drill and compass saw.
- If a sheathing board is cut in two, provide a support cleat underneath it.
- Remove the top shingle in which the hole is cut.
- Cut any shingle nails that will obstruct the jack flange. This can be done with a nail saw or ripper.
- Slip jack into place.

Caution: Never apply flashing compound on top of an existing wood or composition shingle roof because it will dam water, causing it to back up and leak into the building.

Installing a pipe jack on an existing built-up roof. When installing a pipe jack on an existing built-up roof, the roofer should spud off the gravel around the area where the hole will be located. After cutting the hole, the roofer should set the jack in place, apply felt and asphalt to match the construction of the existing roof, and then regravel around the jack.

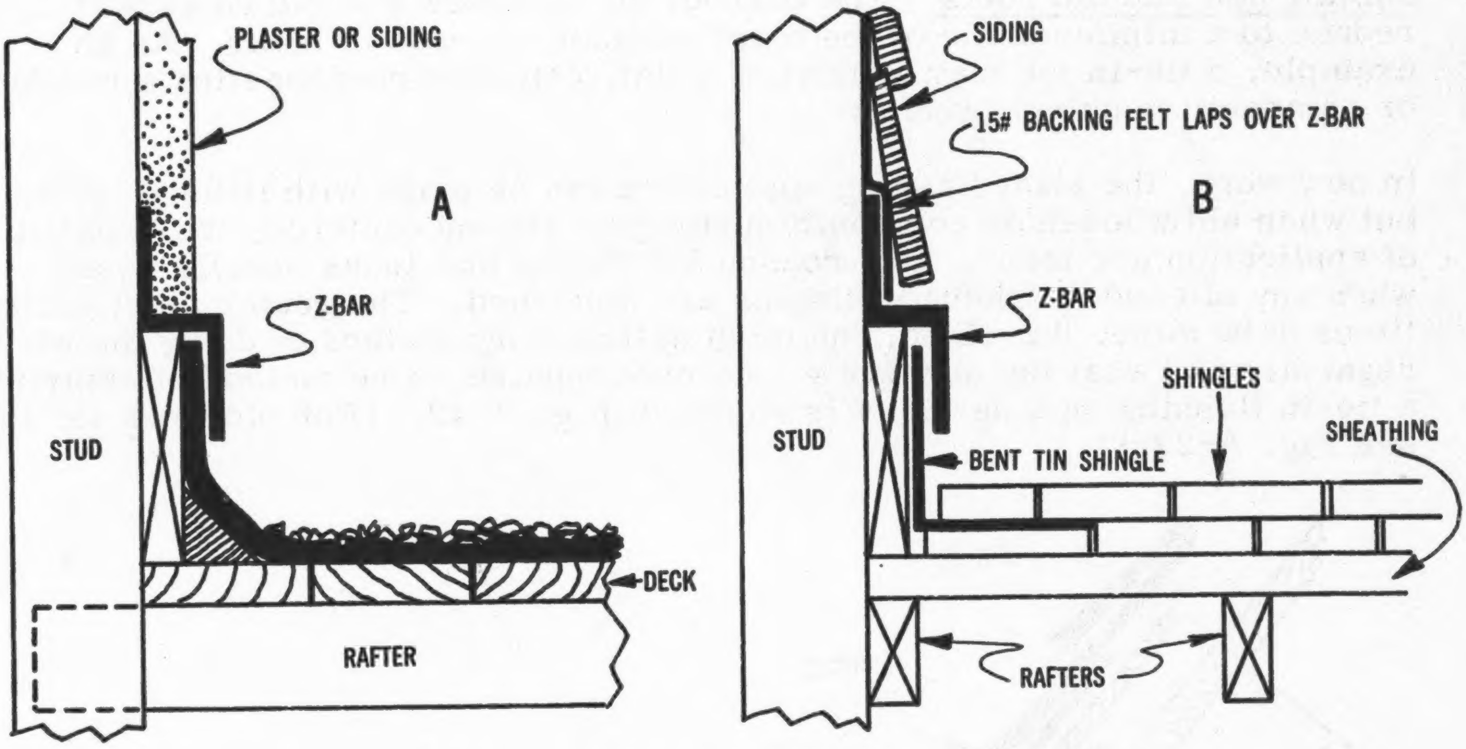
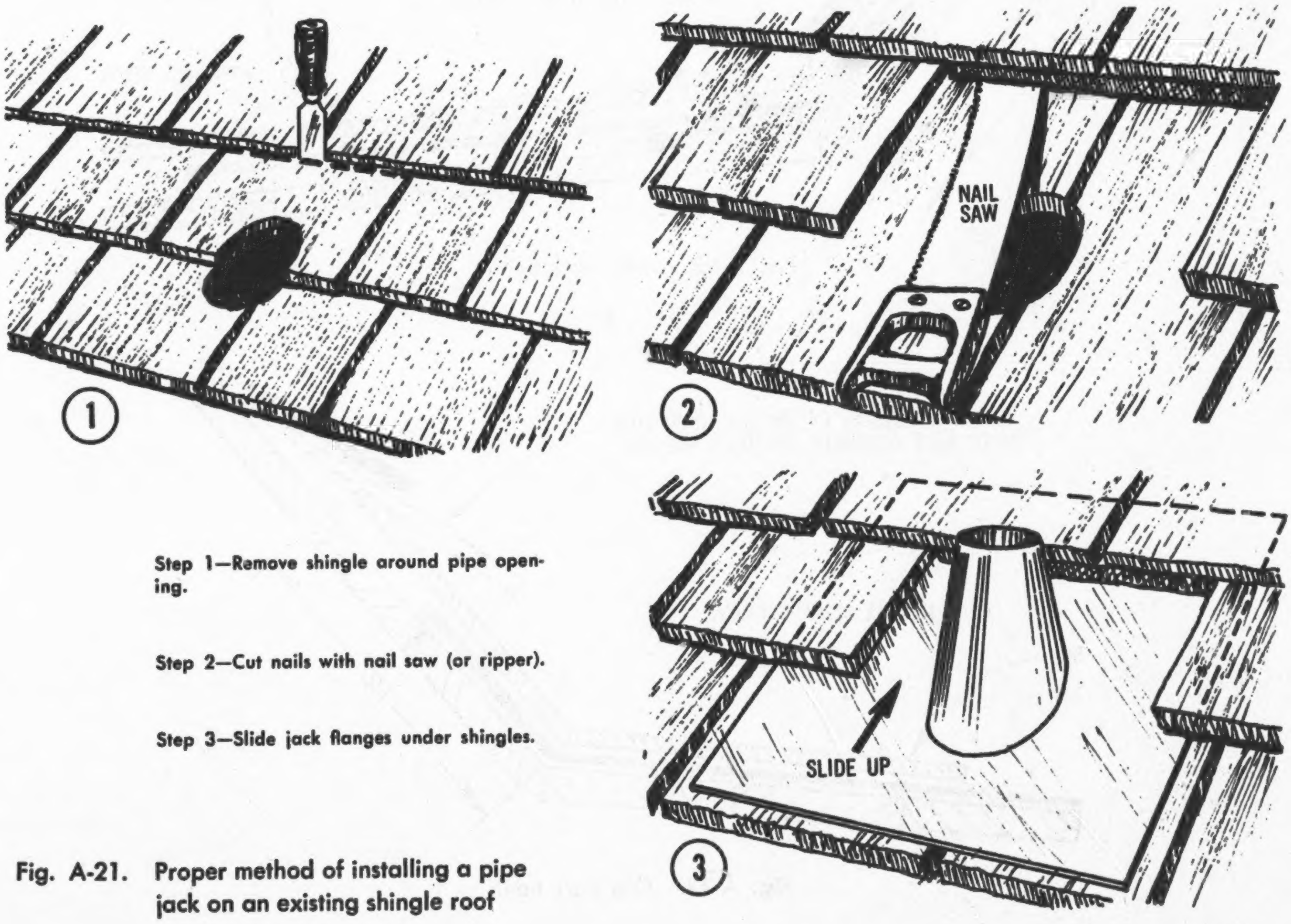

PLASTER OR SIDING
A
Z-BAR
STUD
DECK
RAFTER
SIDING
15# BACKING FELT LAPS OVER Z-BAR
B
Z-BAR
SHINGLES
SHEATHING
STUD
BENT TIN SHINGLE
RAFTERS

Fig. A-20. Proper flashing procedures using Z-bar


NAIL SAW
SLIDE UP
①
②
③

Step 1—Remove shingle around pipe opening.

Step 2—Cut nails with nail saw (or ripper).

Step 3—Slide jack flanges under shingles.

Fig. A-21. Proper method of installing a pipe jack on an existing shingle roof

Joining new and old roofs. The correct tie-in of new and old roofs will reduce to a minimum one of the most common sources of leaks. As an example, a tie-in job may consist of a flat, capsheet roof meeting a wooden or composition shingle roof.

In new work, the ideal flashing application can be made with little trouble, but when old wooden or composition shingles are encountered, the problems of application are many. One reason for this is that leaks usually result when any old and weathered shingles are disturbed. The roofer must sometimes determine, therefore, the most satisfactory method of doing the work, regardless of what the new work code may require. One method of applying a tie-in flashing on a new roof is shown in Fig. A-22. (For old work tie-in, see Fig. A-23.)

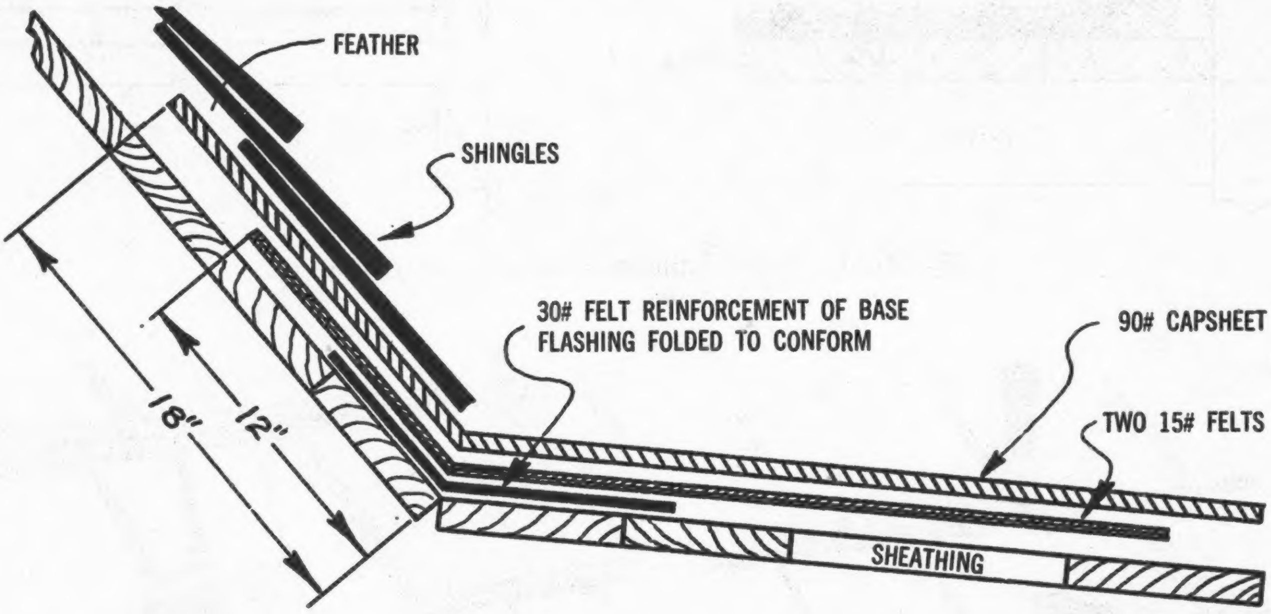

FEATHER
SHINGLES
30# FELT REINFORCEMENT OF BASE FLASHING FOLDED TO CONFORM
90# CAPSHEET
TWO 15# FELTS
18"
12"
SHEATHING

Fig. A-22. New work tie-in

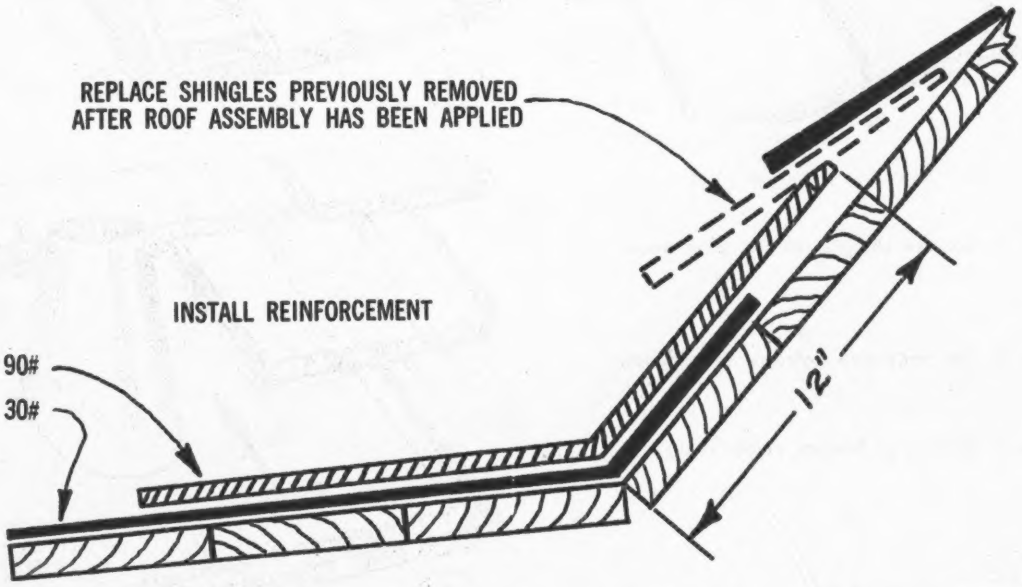

REPLACE SHINGLES PREVIOUSLY REMOVED AFTER ROOF ASSEMBLY HAS BEEN APPLIED
INSTALL REINFORCEMENT
90#
30#
12"

Fig. A-23. Old work tie-in

Codes and Ordinances

Minimum requirements governing flashings are set forth by most building codes. The Uniform Building Code (Topic 1, Part 2) is generally accepted throughout the nation as a minimum and may be followed where no local codes have been prepared. It is impossible, of course, to cite all of the variations throughout the state and nation. Some essential points to keep in mind, however, are the following:

- FHA property requirements apply where they exceed the local code.
- Military specifications are usually of superior quality to local codes and can vary considerably with the building structure and its location.
- If unfamiliar with local area practice, the roofer is wise to consult with the local building and safety department.

Study Assignment

1. James McCawley, Roofing: Estimating-Applying-Repairing, pp. 52-65, 279-85, and 303.
2. J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products, pp. 25-37.
3. Built-up Roof Specifications. Los Angeles: The Flintkote Company, 1964, pp. 163-86.

UNIT A--BUILT-UP ROOFING

TOPIC 3--FLASHING

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Quality flashing is usually specified for competitive work. 1. T F
2. Since it is the responsibility of the architect to specify the type of flashing to be used, the roofer need not be concerned with knowledge of flashing materials. 2. T F
3. The possibility of organic matter getting onto the roof should be considered in the selection of flashing. 3. T F
4. There are two general types of flashing. 4. T F
5. There is no way to determine by observation alone the quality of galvanized flashing. 5. T F
6. The chief advantages of aluminum flashing are its strength and durability. 6. T F
7. It is necessary to use plastic cement between the joints of gravel guard, even when the roof is pitched. 7. T F
8. All plumbing and heating contractors are capable of installing pipe jacks correctly in existing roofs. 8. T F
9. At least four layers or courses of shingles must be removed when a composition shingle roof is tied in to a new addition. 9. T F
10. The usual thickness of galvanized iron used for flashing is 24 gauge. 10. T F
11. Asphalt, kerosene, gasoline, and motor oil can all be considered compatible. 11. T F
12. Lead flashing will last many years and is extremely easy to cut and form. 12. T F

13. A cricket is used sometimes at the base of walls as a substitute for cant strip. 13. T F

14. One factor to be considered when selecting flashing to be used on a job is the ease with which a reroofing job can be done. 14. T F

15. Metal edging should always be sealed to keep moisture from penetrating the roof. 15. T F

UNIT A--BUILT-UP ROOFING

TOPIC 5--SUMPS AND DRAINS

This topic, "Sumps and Drains," is planned to help you find answers to the following questions:

- How many basic types of roof drains are there?
- How is a ring drain usually installed?
- Why are sump drains and overflow scuppers similar in function?
- How is a new roof prepared for the installation of a drain?
- When should an old drain be replaced, and how is this done?

Proper roof drainage is a prime factor in roof life. Standing water causes roofing to deteriorate, and, if left undrained, it will damage the structure itself by causing dry rot. In addition, excess water collecting on a roof in large amounts will often cause roof collapse because of the excess weight for which the roof structure was not designed.

The prime contractor has the responsibility of constructing the roof deck in such a manner that correctly applied roofing will allow prompt drainage. But the roofer has the responsibility of applying the roof and drains so that no obstruction will present itself to water flow.

The steeper the roof, the faster the drainage, and flat roofs drain slowly. A dead-flat roof theoretically will drain evenly in all directions; however, a low spot anywhere in the field of such a roof can easily cause a problem of serious proportions. The correct installation of drains and the repair of drains already installed are perhaps the most critical jobs performed by the roofer.

Installation of Drains

There are four basic types of drains: the ring drain, the wall drain, the sump drain, and the overflow scupper.

Ring Drains

The ring drain is a cast iron clamp-type drain consisting of three main parts: base, clamp ring, and strainer. If the roof deck in which the drain is to be installed is to receive insulation, the following installation procedure is recommended:

- Apply the insulation first. (If the plumber has connected the drain pipe, you must be extra cautious when applying materials. It is sometimes wise to insert a rag or other similar material into the pipe to keep asphalt, bits of roofing felt, gravel, or any other substances from falling into the pipe and obstructing it.)
- Taper the insulation back at least 18 in. all around the opening to allow the drain to be set slightly below the deck level (Fig. A-24).

If the deck is not to receive insulation, proceed as follows:

- Follow the deck around the drain opening in the same manner as was done with insulation. The drain should be set so that its outside edge is no closer than 12 in. away from curbs, walks, or other vertical projection at any point.
- Fill the base clamp ring groove with plastic cement before applying any roofing.
- Extend roofing felts over the ring groove during the course of roofing application.
- Trim roofing felt evenly at inside edge of the ring after all felts are in place.
- Install the clamp ring and tighten clamps securely before the asphalt cools.
- Apply gravel surfacing (if specified) flush to the top on the clamp ring.
- The application of a 6-in. lead collar is sometimes specified. This collar will prevent the clamp ring from breaking the roofing material.

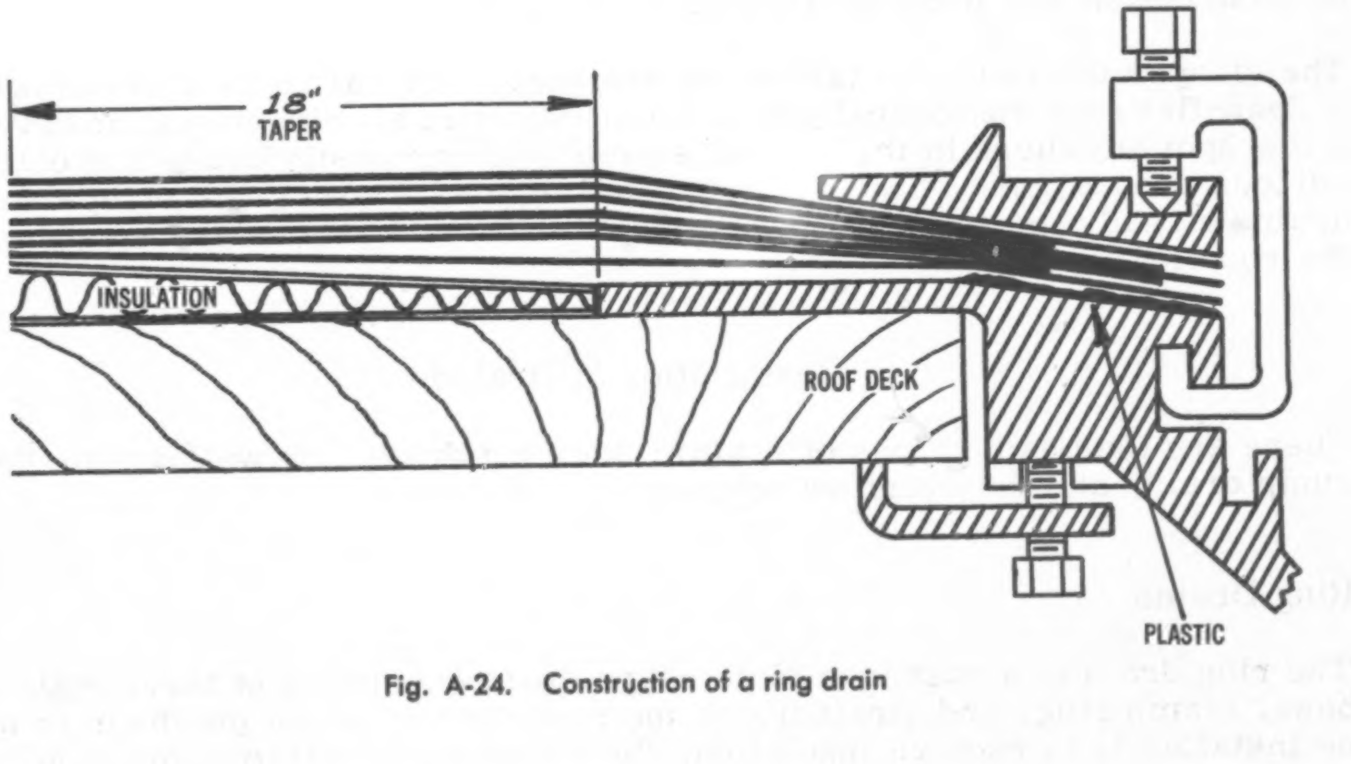


Fig. A-24. Construction of a ring drain

Sump Drains

A sump drain is usually a recessed box made of sheet metal with a screen basket at the bottom (Fig. F-15). This type of drain usually empties directly into the street or sewer. Sump drains are usually installed on wooden decks.

A sump drain should be installed as follows:

- Apply a layer of felt around the drain opening in the roof deck. This opening will contain the outlet box.
- Trowel a coating of plastic cement over this felt, being certain to cover the area surrounding the opening and wide enough to include the entire flange area.
- Drop the outlet box into place, and nail the flange around its outside edge.
- Apply an additional layer of flashing compound with fabric on top of the drain flange to ensure a watertight job.
- Apply the built-up roofing. The felts used should be tapered back away from the drain at least 18 in. on all sides.

Overflow Scuppers

Scuppers are used for much the same purpose as sumps, and the installation is quite similar, except that the scupper is installed on a vertical surface (an outside wall) and the tapering procedure is not necessary.

A scupper is always installed in conjunction with the application of wall flashing, and extreme care must be taken to see that it is made watertight (Fig. A-25).

Overflow scuppers are usually placed in a wall 2 to 4 in. above the lowest part of the deck. They serve as "safety valves" in the event the main drains at deck level become clogged.

Wall Drains

Wall drains are installed in a manner similar to sumps and are made for installation in left corners, right corners, or the middle-of-the-wall (Fig. A-26). The recommended procedure for installing wall drains follows:

- Apply a layer of felt completely surrounding the drain area, followed by an application of plastic cement.
- Install the outlet box into the wall opening, allowing at least three inches to extend beyond the outside surface of the wall. This extension provides a suitable drip edge for water drainage.

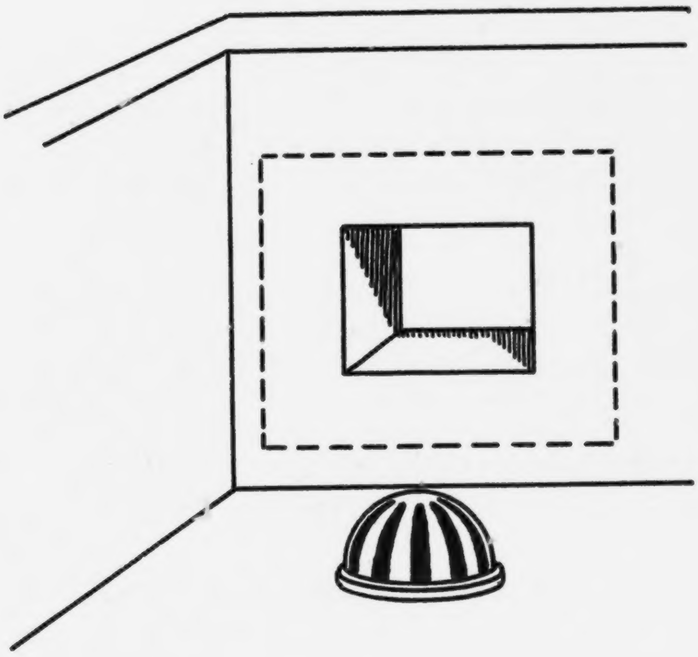


Fig. A-25. Overflow scupper

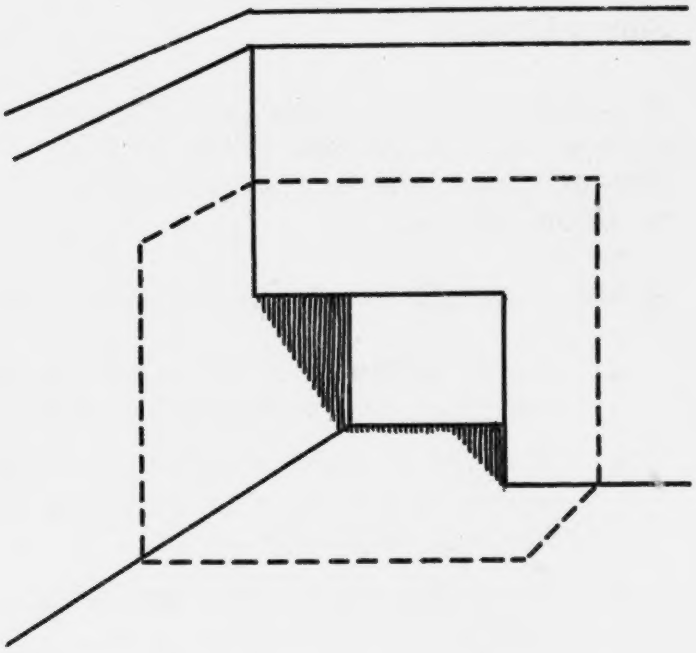


Fig. A-26. Wall drain

- Apply an additional layer of plastic cement on the flange above the drain opening. This layer should not be too heavy; otherwise,it can slide down in hot weather and plug the opening.
- Apply the remaining felts in the usual manner for parapet flashing.

Repairing and Reroofing Operations

In reroofing operations, a sump or scupper drain should be checked carefully for corrosion and leaks. Replacement of rusty outlet boxes is always recommended, but this can be quite expensive. An attempt to remove a partially rusted sump or outlet usually results in breaking the metal, which renders the assembly completely useless.

If a rusty outlet box is fairly sound, it is possible to add a few more years to its service in the following manner:

- Clean all dirt, gravel, and debris away from the box.
- Mop solidly around the box with hot asphalt.
- Mop one side of Irish flax, and apply it so that it extends down and covers the inside of the box.
- Mop solidly again with hot asphalt.
- Apply the new built-up roofing.

Sometimes an old drain will have a completely deteriorated box that cannot be used. In this case, the following steps should be taken:

- Remove the old box and check the deck for dry rot.

- Prepare the deck in the usual manner for reroofing.
- Feather the old roofing back from the drain opening at least 3 ft.
- Apply a new box as you would on a new roof, feathering the roofing material carefully to ensure good drainage.

UNIT A--BUILT-UP ROOFING

TOPIC 1--SUMPS AND DRAINS - Study Guide and Checkup

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) select the word that belongs in each numbered space in an exercise; and (2) write the word at the right in the space that has the same number as the space in the exercise.

1. The cast iron clamp drain consists of three parts: ___1___, clamp ___2___, and ___3___.

   1. __________
   2. __________
   3. __________

2. Insulation should always be tapered back at least ___4___ inches from a drain opening.

   4. __________

3. There are four basic types of drains: ___5___, ___6___, ___7___, and ___8___.

   5. __________
   6. __________
   7. __________
   8. __________

4. After the roofing has been laid around a ring drain, the felts should be ___9___ evenly around the ___10___ edge.

   9. __________
   10. __________

5. A sump drain is usually a ___11___ box of sheet metal with a screen basket at the ___12___.

   11. __________
   12. __________

6. A sump drain usually empties directly into the ___13___ or ___14___.

   13. __________
   14. __________

7. Overflow scuppers are used for much the same purpose as ___15___ drains.

   15. __________

8. A scupper is always installed in conjunction with ___16___ ___17___.

   16. __________
   17. __________

9. A wall drain box, when installed, should extend ___18___ inches past the outside surface of the wall.

   18. __________

10. Whenever a new drain outlet is installed to replace an old one, the existing roofing material should be ___19___ to ensure good ___20___.

    19. __________
    20. __________

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. On reroofing jobs, the roofer should replace all existing drains. 1. T F

2. Overflow scuppers are usually placed 4 to 6 in. above the roof deck. 2. T F

3. When a roof is to receive insulation, the drain should be placed even with the top surface of the insulation, but under the roofing felts. 3. T F

4. There are two basic styles of wall drains. 4. T F

5. Low spots on a new roof deck can always be compensated for by feathering the built-up roofing. 5. T F

6. Wall outlets should have a drip edge of at least 3 in. 6. T F

7. The ring drain is a cast iron clamp-type drain. 7. T F

8. Scuppers and sump drains are similar in function. 8. T F

9. Scuppers require the same tapering procedure as sump drains. 9. T F

10. Wall drains are designed only for corner drainage. 10. T F

UNIT A--BUILT-UP ROOFING

TOPIC 6--ROOFING REPAIRS

This topic, "Roofing Repairs," is planned to help you find answers to the following questions:

- What are the most common conditions that lead to roof leaks?
- What tools and equipment are generally needed for roof repair work?
- What is the best method of locating a roof leak, and when is the best time to look?
- What are the two main repair procedures for patching leaks, and when are they used?

Locating and repairing leaks is an important phase of the roofer's work. The man who possesses the skill and knowledge necessary to perform this work efficiently is often the man who enjoys full employment all year, instead of having to depend entirely on the uncertainties of the construction field. The roofer who has a good general knowledge of building construction has an advantage in this work.

Roof leaks may be repaired not only when it rains but anytime when other work is unavailable. The roofer who can be kept busy finding and repairing leaks can realize a substantial increase in his annual income. Roof repair can be considered a specialized field in the roofing trade, and nowhere is this more evident than in huge industrial complexes where there may be acres of roof areas to maintain.

Types of Leaks

A leaking roof may be caused by many things, but most leaks may be classified into three main types: obvious, difficult, and hidden. Almost any roofer can fix an obvious leak; that is, one where the location and cause of the leak is visible. A difficult leak may be one in which the cause is not at all obvious; one may see the water leaking inside the building, but the opening or fracture in the roof is not easy to find. The hidden leak is the worst and one that challenges the skill, imagination, and ingenuity of the roofer.

Causes for Leaks

A roof may leak for many reasons, but one fact is inescapable: if a roof is leaking, there is a point somewhere that is not watertight. If the roofer is familiar with the most common causes for leaks, he knows what to look for and where he is most apt to find the trouble.

Listed here are some of the most common causes for roof leakage or the most common locations that may be reasonably suspected of giving trouble:

- Dried caulking at counterflashing reglets on chimneys and masonry walls
- Nails that have backed out of the deck
- Improperly primed surfaces from which roofing has peeled away
- Cracks in the base flashings
- Incorrectly installed new vents on wood shingle roofs and vents which have been incorrectly installed after the roof has been applied
- Cracks on large roofs where expansion joints should have been installed
- Cracks in roll roofing material caused by lifting in the wind
- Inside and outside corners which have been incorrectly cut, folded, or sealed
- Broken tile or cement copings on parapets
- Incorrectly installed air conditioning equipment or breaks caused by vibration of such equipment
- Breaks or openings around flagpoles, signposts, guywire attachments, and the like, where the necessary pitch pans were not installed
- Roof areas over which traffic has moved, creating cracks which are not immediately apparent to the eye
- Cracked stucco walls or incorrectly installed flashing on stucco or siding
- Faulty installation of roofing felts, such as insufficient asphalt between layers
- Structural problems, other than those caused by poor design or construction (sometimes due to settling)
- Careless or poor work by other tradesmen in the installation of their work prior to application of the roof
- Inadequate inspection and correction of deck defects prior to the application of the roof
- Defective or poor quality roofing materials
- Rusted outlet boxes and flashings
- Wood shingles with cracks over cracks
- Capillary action where flashings are not high enough
- Blistering of the felts
- Improper installation of sky lights

- Oxidation of the roofing surface, weathering from the elements, or corrosive residue from manufacturing processes
- Extreme variations in temperature and humidity, causing severe expansion and contraction of the roof
- Poor patching
- Errors in original roof specifications or structural design
- Improperly installed gravel stops, edgings, and flashings
- Water from condensation on heating or cooling ducts and pipes. (These items often drip and appear to be leaking although they are not. The water, however, is just as damaging.)

Tools and Equipment

The roofer who is assigned to "chasing" leaks will find his work easier and more successful if his truck (sometimes called the "patch wagon") carries the right repair materials, tools, and equipment. Only a ladder may be needed to find a leak on one job, but it may require anything on the truck to do the repair. Sometimes temporary repairs are made during a rain, and permanent repairs will be made later when the roof is dry. But it is a great saving to the contractor (and the customer) if the second trip can be avoided by making a permanent repair on the first call.

The Patch Wagon

The following is a suggested list of tools, materials, fasteners, and equipment for a "patch wagon":

Ladder (two-story type)
Spud bar
Shovel
Heavy broom
Hand cleaner
Rags
Wet patch and plastic
Fabric (cotton or glass)
Mineral surface material (90-lb.)
Tin shingles
Nails (cement, 7/8-in. and 1 1/4 in.)
Hand line
Pencil and pad with clipboard (used to draw sketches necessary for locating leaks, and for writing information needed for reports on the back of job sheets)

Note: Should the roofer notice upon arriving at a repair job site that the roof is in such bad condition that even temporary repairs are not possible, it is wise to measure the roof, make a working sketch, and outline the work that should be done. The contractor can use this information to estimate and sell a new roofing job. In this way, the roofer has not wasted his time on the job and, perhaps, has created a job for himself in the process.

Personal Tools and Equipment

The roofer should have the following tools and equipment with him on repair jobs:

- Nail bag
- Hatchet
- Claw hammer
- Knife
- Crowbar
- Wirebrush
- Whisk broom
- Tin snips
- Small pointing trowel
- Rain gear
- Rubber-soled shoes
- Tennis shoes

Tools for Permanent Repairs

Permanent repairs are generally done from reports prepared by someone who has inspected the job beforehand. Permanent repairs usually require two men. In addition to the tools and equipment already mentioned, the following items should be brought to the job:

- Small patch kettle
- Small mop and bucket
- Rope and wheel
- Irish flax
- Roofing felt (15-lb.)
- Mineral surface capsheet (90-lb.)
- Bagged rock
- Asphalt

Locating Leaks

Roof conditions which indicate possible leaks can be recognized most any time by the experienced roofer, but the best time to locate a leak is during a rain. Sometimes during dry weather a leak may show up when water is turned on the roof by means of a garden hose, but this method is seldom successful. All too often, the point in the building at which the leak appears is far removed from the point on the roof at which the water has entered the roofing material. As a consequence, a roofer must often trace the flow of water along pipes, rafters, beams, and sheathing until he arrives at the source. This is done best during a rain.

The following procedure is a good way of locating a leak point on a roof by using evidence found inside the building:

- Step off, inside the building, the distances the leak is from points visible from the outside; for example, outside walk, skylight, chimneys, pipes, and the like.
- Make a diagram of these findings, including anything that is easily discernible from the roof.
- On the roof, use the diagram to locate the area above the leak, and look for obvious signs of damage in and around that area. Mark the roof with keel in this area. You may immediately detect something which is obviously causing a leak, but this does not mean you should stop looking.

A roof leak is sometimes very deceiving, and the roofer must look at every possibility. For example, sometimes the roof deck has been roofed more than once. One way to determine this is by making a cut in the roof in the form of a V, then lifting the roofing at the intersecting point. A previous roof may be found underneath. If only one built-up roof has been applied, then the chances are that the defect will be found in the immediate area above the interior point of leakage. But if more than one roof has been applied, the roof defect may be far removed from this area. This is because the water, getting through the new roof, will travel underneath it and on top of the previous roof until it finds an opening into the building.

Once located, a temporary repair may be indicated with a permanent repair called for at a later date. In this event, a full report should be made to help those who will make the second call. This report should include the following information:

- Special equipment that will be required
- The type of material that will be needed and how much
- Number of men and man hours that will be required
- General recommendation as to what should be done
- Diagram of the roof and dimensions

Whenever possible, it is best to assign a repair job to the man who worked on the original roof application. This man will know what kind of deck lies underneath the roofing, the quality of the overall structure, what deck defects were covered up, and how the materials were applied. It may be that this man is not the best qualified to find and fix the leak (repairing is a specialized field), but he should at least be consulted because he knows many things that might require several hours to discover by someone who is not familiar with the specific job.

Repair Procedures

Although some roof repairs must be made during dry weather, others can be done during rain. Whether these repairs are temporary or permanent in nature, the procedure used is basically the same.

Patching Leaks in the Rain

The following procedure may be followed when patching a leaking roof during rain:

- Clean away any rocks or dirt with a spud bar or wire brush in the vicinity of the leak. Prepare a smooth surface for the patch.
- Using a wet patch, spread the material over the wet surface, working it in until a good bond is made over and around the spot where the leak has occurred.

- Place glass or saturated cotton fabric over the wet patch.
- Smooth additional wet patch over the fabric.

(Note: This process may be done under water if necessary, but it will require more "working-in" to establish an adequate bond.)

Repairs on a Dry Roof

The basic procedure to follow when repairing leaks on a dry roof is as follows:

- Clean all dust and gravel away from the repair area.
- Use hot asphalt in the same manner as on a reroofing job.
- Prime all dry and dusty areas
- Cover any rough or irregular surfaces with Irish flax, and cover this immediately with gravel or 90-lb. felt.
- Apply mastic, plastic, or other flashing compound around pipes, flashing, and 3-course roofing instead of wet patch.

Safety Factors

The following safety precautions should be taken to prevent accidents and possible injury:

- Exercise extreme caution when working on wet wood shingle roofs, for they can be very slippery if they are covered with moss or if they have been painted with graphite.
- Make certain that ladders have a secure footing, especially when placed on saturated soil. Only wooden ladders should be used because they are heavy enough to withstand moderate wind without blowing over and because wood is a poor conductor of electricity. Also, a wooden extension ladder, when extended to its last rung, is not so apt to buckle as an aluminum ladder. Always tie a ladder to a secure gutter, roof jack, or other object that will hold it in place.
- Never climb a ladder during an electrical storm.
- Keep a safe distance away from all electric wires, especially during wet weather or while on a wet roof.
- Avoid, if possible, walking on a roof during freezing weather when ice patches are prevalent.
- When working in an attic area, step only on supports such as ceiling joists, cat walks, beams, and the like. Never step on or rest against a plastered area.
- Always use "chicken ladders" on extremely steep roofs.

Special Precautions

When it is necessary to enter a house or building after having been on the roof, take the following precautions:

- Make sure there is no mud or asphalt on your shoes--change shoes if necessary before entering building.
- Check clothing the same way, especially for evidence of asphalt that could rub off on something.
- Do not touch walls, ceilings, or similar surfaces when inspecting for leaks unless your hands are clean and dry.

Topics for Discussion

Be prepared to discuss the following topics if asked to do so:

1. What are the seven most common sources of leaks on a skylight?
2. What may be called a leak, but really isn't?

UNIT A--BUILT-UP ROOFING

TOPIC 6--ROOFING REPAIRS

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The patching of leaks accounts for a large portion of roofing work. 1. ____________
2. In most cases, the cause for a roof leak is easily determined. 2. ____________
3. A ladder, a broom, some wet patch, and fabric are all the essentials needed for repairing leaks. 3. ____________
4. Permanent roof repairs are always done by the man who made the initial inspection. 4. ____________
5. The best time to locate and repair a leak is right after a rain. 5. ____________
6. It is best to find the location of the leak on the inside of a building before getting onto the roof. 6. ____________
7. When an obvious cause for a leak is found, such as a hole in a base flashing, the roofer should patch it and go on to the next job. 7. ____________
8. Whenever possible, the roofer who originally installed the roof should be sent out to repair it. 8. ____________
9. Almost any roofer is qualified to do patch work. 9. ____________
10. Irish flax is an excellent material to use for patching leaks. 10. ____________
11. Adequate and satisfactory repairs may be made to a leaking roof in the rain. 11. ____________
12. Mastic and wet patch are equally good to use on a dry surface. 12. ____________
13. The best ladder to use on a roofing job is one made of wood. 13. ____________

14. It is not possible to patch a leak properly while the leak area is under water. 14. ________

15. Cracks in base flashing will always result in a leak. 15. ________

UNIT A--BUILT-UP ROOFING

TOPIC 7--DAMPPROOFING AND WATERPROOFING

This topic, "Dampproofing and Waterproofing," is planned to help you find answers to the following questions:

- What is the difference between waterproofing and dampproofing?
- What materials are most commonly used in waterproofing?
- What special safety precautions should be observed when waterproofing an excavated basement area?
- What problems are generally encountered in the waterproofing of residential slabs?
- What are the procedures used in preparing a shower pan?

The waterproofing of a building is so essential that if improperly done the building can be rendered unusable for any purpose. Knowledge of the principles and practices of waterproofing techniques should be acquired by the roofer, for this will prove to be of inestimable value to the roofing contractor and earn the appreciation of the building owners.

The skills needed for this work are not unlike those practiced in ordinary roofing, except that more of the work must be done in cramped quarters, on vertical surfaces, and from scaffolding.

Floors and walks exposed to excessive moisture below grade must be waterproofed to prevent the intrusion of moisture. Also waterproofed are planter boxes, reflection swimming pools, reservoirs, canals, showers, and the like to prevent moisture from escaping.

Waterproofing

In either case, membrane waterproofing is applied; that is, alternate layers of asphalt-saturated felt and hot or cold asphaltic coatings or special adhesives. A membrane may also consist of a single layer of plastic or rubber sheeting applied to the wall (or floors) with an appropriate adhesive.

Underground springs, water from excessive run-off, proximity to lakes and rivers, or water conditions resulting from industrial processes are all conditions that may result in a need for waterproofing structures.

Under the conditions described water can exert up to 62.5 lbs. pressure per square foot against the underside of a basement floor or the outside of a below-grade wall. Were it not for the resistance of the earth against the surfaces of the foundation footing and the walls, a building could actually float. This should emphasize the importance of an adequate waterproofing job in these areas, for with this kind of pressure, it is not difficult for water to find a way into a basement.

Dampproofing

Dampproofing is done where moisture without hydrostatic pressure is present. Only asphaltic or pitch coatings and water repellants are applied. Dampproofing may be done on above- or below-grade surfaces.

Materials Used

All roofing material manufacturers produce materials for use in various dampproofing and waterproofing applications. For the most part, standard products are used throughout the construction industry. There are, however, a few specialized materials, such as canal, reservoir, and pool liners; silicone water repellants; plastic and rubber sheeting; and appropriate adhesives for application.

The most common materials used are the following:

Fifteen-pound perforated and nonperforated saturated felt. This is the same material used in all roofing work and is the most common membrane used under basement floors and walls.

Polyethylene and neoprene sheeting. This plastic sheeting may be applied over a troweled-on adhesive. It is sometimes laid loose on the ground (or base slab), over which concrete is poured.

Fibrated and nonfibrated asphaltic plastic. This is the same material used on roofing operations for installing standard 3-course, sealing corners, and similar work.

Catalyzed adhesives. These adhesives are used in the application of neoprene rubber sheet material.

Webbing. Webbing is used as a reinforcement material in or on joints when motion may be expected to occur because of expansion, contraction, or vibration of the structure.

Asphaltic emulsions. These are the same emulsions used for cold-roofing applications. They may be of two types: fibrated and nonfibrated. A fibrated emulsion is one in which a certain amount of asbestos fiber has been added for extra strength. Since this compound is emulsified (mixed with water under pressure and subjected to violent agitation), it hardens after application as the water evaporates and is no longer soluble in water.

Primer. A primer may be purchased in a prepared form or made on the job by cutting back bitumen with kerosene. (Caution: Neither gasoline nor paint thinner should ever be used for this purpose.) Primer is used prior to the application of hot asphalt, pitch, or emulsions to prevent the absorption of their essential oils and to provide better adhesion.

Water repellants and coatings. These products consist mainly of silicones and vinyls and are brushed or rolled on in their application.

Caulking compounds. Caulking compounds may be either knifed or gunned into place. They are specifically designed to fill cracks or provide a seal between two structural materials.

Asphalt and coal tar pitch. These are the same types of materials used on other phases of roofing work. The asphalt may be high-, medium-, or low-melt variety. Because the surfaces to which these materials are applied on a waterproofing job are cold, the asphalt or pitch becomes brittle, usually fractures, and is always a potential cause for leaks.

Seventy-pound felt or 1/2-in. saturated fiberboard. Either one of these products may be used over a membrane to prevent accidental puncture during backfilling operation.

Hand Tools and Equipment Used

The hand tools used for dampproofing and waterproofing are the same as those used in any roofing operation. High-pressure spray guns, rollers, and brushes are used to apply asphaltic emulsions, liquids, and primers. (See Unit C, Topic 6, Roofing, Part 1.)

Because foundation wall waterproofing usually takes place in excavated areas and walls may be from 10 to 40 ft. or more high, a roofer may have to erect a simple scaffold or use two ladders with ladder brackets as a scaffold. Generally, the work is up so high that the backfilling is done as the waterproofing work progresses.

Safety Rules and Precautions

All safety rules previously listed for general roofing operations apply to waterproofing work. Some additional rules applying specifically to these operations follow:

Scaffold Safety

Before the work is started, the scaffold and the ground upon which it rests should be inspected to provide answers to the following questions:

- Is the excavated earth firm and not subject to caving? (Cement is often "gunited" over the earth to hold it solidly.)
- Are the scaffold leg pads strong, level, and on a firm footing?
- If the scaffold is of wood, is it properly nailed or bolted?
- Have proper ties been made between the building and the scaffold?
- Does the scaffold deck consist of at least two 2 x 12-in. planks? Is it in sound condition?

The following general safety rules should be observed:

- Never pry between a scaffold and a structure.
- Never overload a scaffold.
- Always secure help to handle awkward loads on a scaffold.
- Always get help when changing scaffold decking.

Refer to Construction Safety Orders for more information on scaffolds.

Application Procedures

The following procedures outline application of dampproofing and waterproofing materials with occasional notes on special safety precautions:

Residential slab

Section views of typical residential floor waterproofing are shown in Fig. A-27.

In geographic areas where freezing may be expected, the floor slab is completely isolated from exterior weather conditions as shown in Fig. A-27 (D). This type of floor may also be constructed without a base slab. Fiber insulation may be included between the floor and the foundation as indicated.

Sometimes "admixtures" are used to make concrete waterproof; such concrete requires no asphaltic applications. Admixtures may be special soaps, treated tallow, lime, or simply a concrete mix rich in cement. Plastic cement, used for stucco, contains a powdered, water-soluble tallow, which makes it waterproof.

Ordinary concrete can be made waterproof by the proper amount of tamping or vibration. This process eliminates pores and air bubbles within the slab which would provide channels for water.

Plans for high-quality residences, however, will have waterproofing specifications equivalent to those of the best class A structures. The following illustrations show section details of waterproofing required on such structures (Figs. A-28 and A-29):

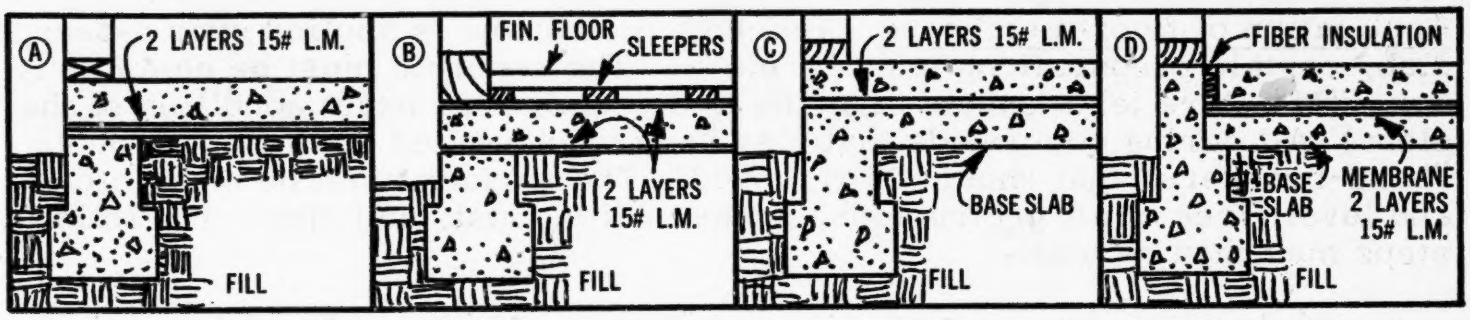

Ⓐ
2 LAYERS 15# L.M.
FILL
Ⓑ
FIN. FLOOR
SLEEPERS
2 LAYERS 15# L.M.
FILL
Ⓒ
2 LAYERS 15# L.M.
BASE SLAB
FILL
Ⓓ
FIBER INSULATION
BASE SLAB
MEMBRANE 2 LAYERS 15# L.M.
FILL

Fig. A-27. Typical residential floor waterproofing

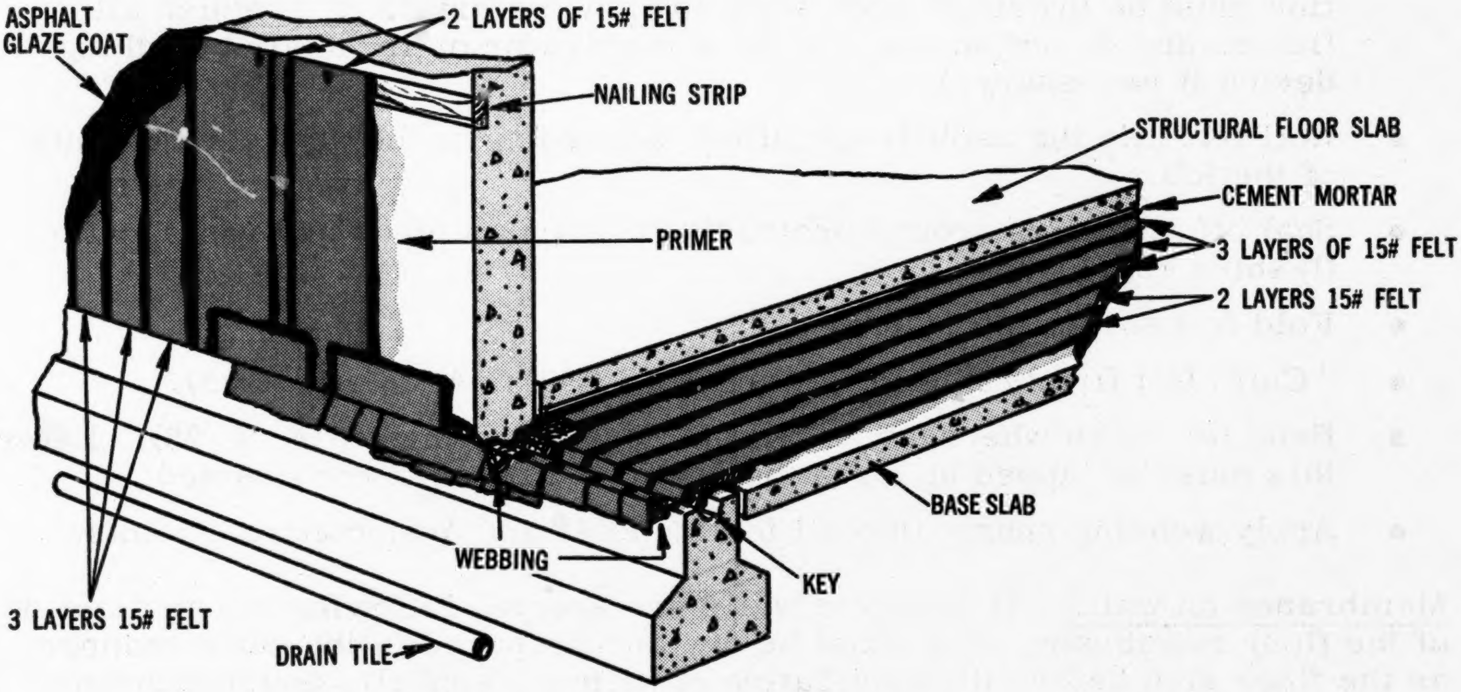

ASPHALT GLAZE COAT
2 LAYERS OF 15# FELT
NAILING STRIP
STRUCTURAL FLOOR SLAB
CEMENT MORTAR
3 LAYERS OF 15# FELT
2 LAYERS 15# FELT
PRIMER
BASE SLAB
WEBBING
KEY
3 LAYERS 15# FELT
DRAIN TILE

Fig. A-28. Outside application of waterproofing on foundation walls

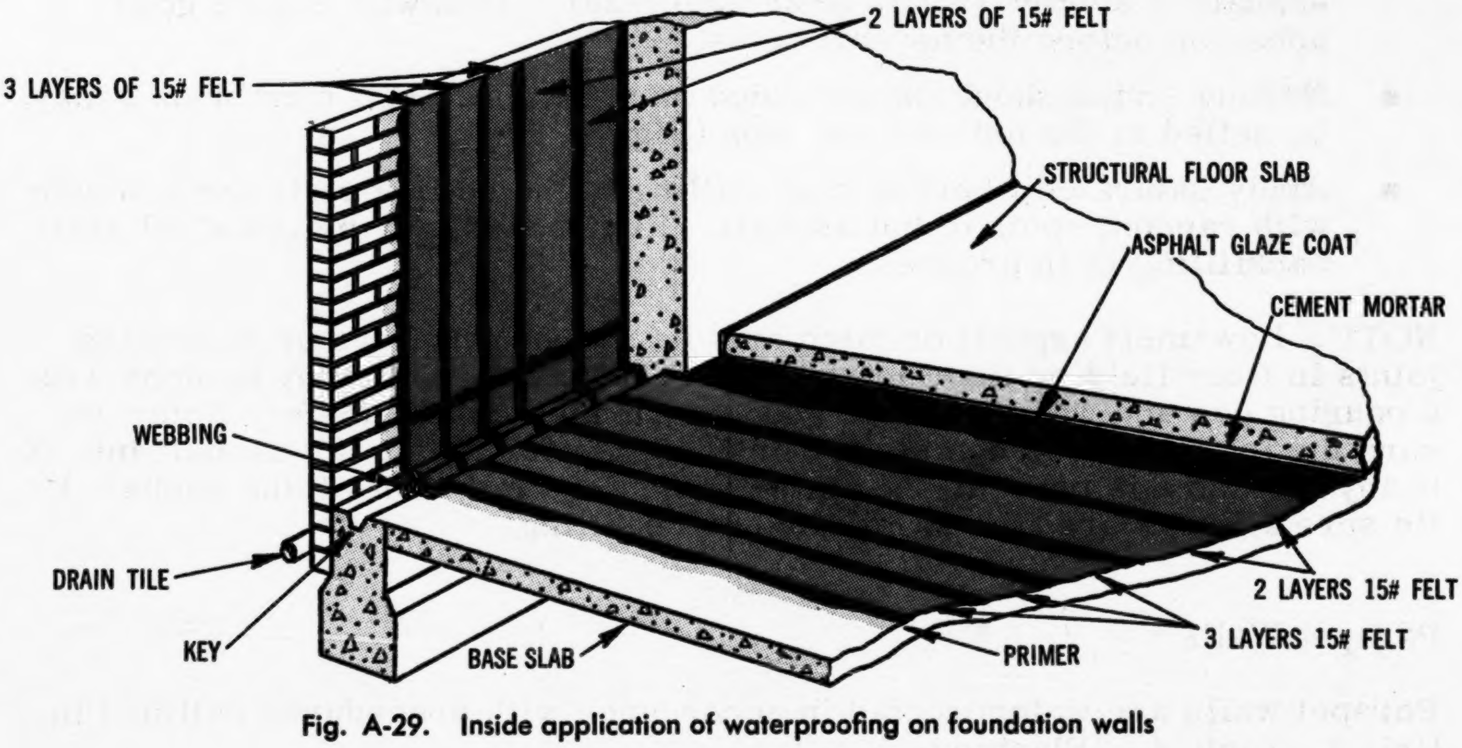

2 LAYERS OF 15# FELT
3 LAYERS OF 15# FELT
STRUCTURAL FLOOR SLAB
ASPHALT GLAZE COAT
CEMENT MORTAR
WEBBING
DRAIN TILE
KEY
BASE SLAB
PRIMER
3 LAYERS 15# FELT
2 LAYERS 15# FELT

Fig. A-29. Inside application of waterproofing on foundation walls

Application of floor membrane. Before a membrane is applied over a base slab, certain preparations must be made. The concrete must be completely dry. (Moisture tests should be made to determine the exact condition of the slab.) All curing compounds that may have been applied form oils or other "bond-breakers" that should be removed. The surface must be made clean and level, free of all protrusions, rocks, nails, dust, and dirt. The following steps may then be taken:

- Apply primer by spray, roller, or brush. (Safety note: Adequate ventilation should be provided when using certain primers. Good ventilation must be provided when spraying any material. Extinguish all flames and do not smoke. Wear a respirator or fresh air breathing device if necessary.)
- Roll felt into the asphalt specified, according to the ply requirements of the job.
- Seal off all points around protrusions, such as pipes and vents, with flashing compound.
- Fold felt snugly into corners.
- "Cuff" felt firmly into all footing keys (Figs. A-28 and A-29).
- Bend felt down wherever it extends beyond footings (Fig. A-28). Later, this must be lapped up on to the vertical wall when constructed.
- Apply webbing snugly into all footing keys and over concrete joints.

Membranes on walls. If concrete walls are erected following the application of the floor membrane, they must be dry and prepared in the same manner as the floor slab before the application of primer, asphalt, and membrane.

- Apply wall membrane from the bottom up and "broom-in" as the asphalt is applied (Figs. A-28 and A-29). This will ensure good adhesion before the asphalt cools.
- Nailing strips should be provided on the wall so that membranes may be nailed at the top with tin caps (Fig. A-28).
- Apply saturated fiberboard by nailing to the nailing strip and sticking with random spots of hot asphalt. Fiberboard may be installed while backfilling is in progress.

NOTE: Low-melt asphalt or pitch may be poured into keys or expansion joints in floor field or floor joints against the wall. This may be done with a pouring can and will provide a good, permanent seal. (Safety Note: Be sure the footing key is completely dry before pouring the hot asphalt into it. If any moisture is present, steam will form and may "blow" the asphalt.) Be sure all keys are free from dirt before filling.

Parapet Walls

Parapet walls are waterproofed in accordance with procedures outlined in Unit A, Topic 4, "Flashings."

Planter Boxes

Planter boxes are waterproofed in the same manner as described for basement floors and walls.

Shower Stalls

When a shower stall is installed over a cement base, the procedure is the same as described for floors and walls. When the shower stall is installed over a wooden base, however, the following procedure for folding and applying a 3-ply felt shower pan should be used (Figs. A-30 and A-31):

- Measure exact pan base size; add turnups.
- Cut and fold as shown in Fig. A-30.
- Sprinkle-mop floor base and apply first pan, cuff into place, and nail folds at top edges. (If a presloped base is encountered, slight modifications in measurement and cuts should be made.)
- Cut drain hole in pan small enough so that its edges extend past the drain clamp ring (Fig. A-31).

  (NOTE: Be extremely careful not to clog the drain weep holes with dirt or asphalt. These are provided to drain any water which may penetrate through possible future cracks in shower tile.)
- Apply a thin coat of fibrated flashing compound at the drain and at the pan corners.
- Measure, cut, and fold next pan, making the joint, or lap, cross the first joint at right angles. Make all corners to fold in opposite direction to first pan's corners (Fig. A-30, points "A" and "B"). The corners are folded in this fashion to reduce thickness. Install pan in manner previously described.
- Fabricate and install third pan in the same manner. Bolt drain clamp ring in place and trim off any excess felt that extends into drain. (In the majority of cases, inspection departments require that the pan be filled with water for 48 hours as a leak test.)

Summary

The basic principles of dampproofing and waterproofing have been set forth in this topic. There are, however, many other materials, situations, and specifications which cannot be taken into account in so brief a treatment.

The roofer must be constantly on the alert for new materials or methods that may be introduced and must learn how to use them before applying them. Many good products entering the market in the past have failed only because the roofer did not take the time or trouble to learn how to use them effectively.

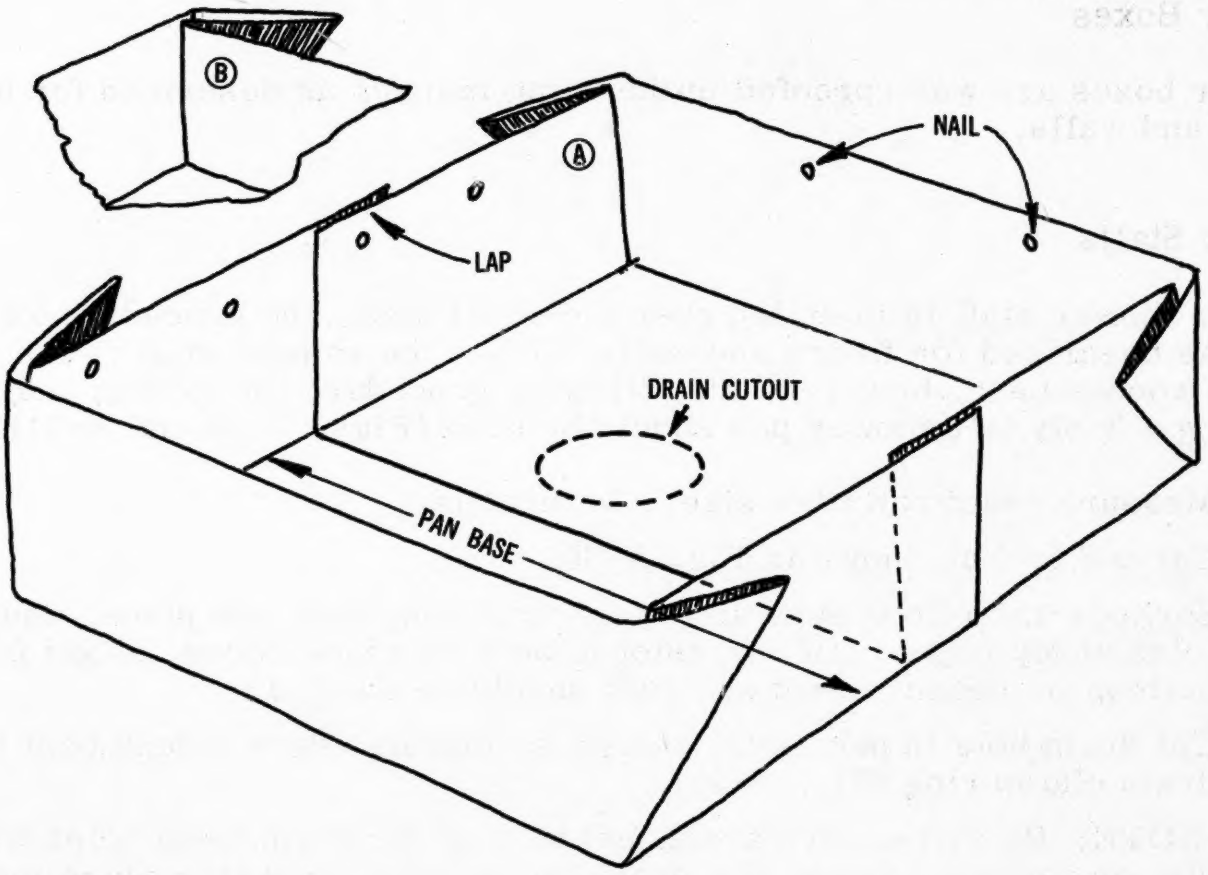

B
A
NAIL
LAP
DRAIN CUTOUT
PAN BASE

Fig. A-30. Construction of shower pan

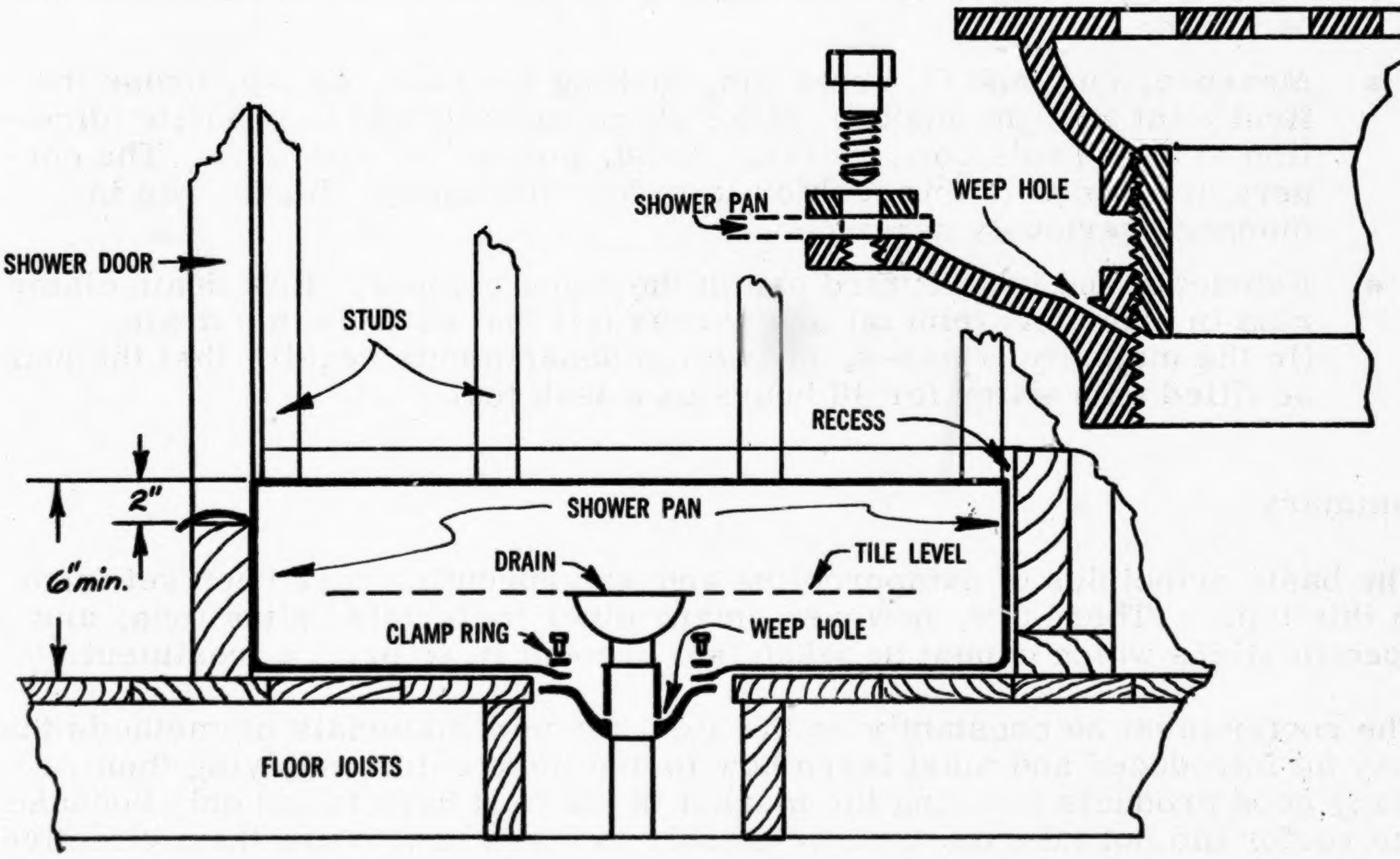

SHOWER PAN
WEEP HOLE
SHOWER DOOR
STUDS
RECESS
2"
6" min.
SHOWER PAN
DRAIN
TILE LEVEL
CLAMP RING
WEEP HOLE
FLOOR JOISTS

Fig. A-31. Installation of pan and drain assembly

UNIT A--BUILT-UP ROOFING

TOPIC 7--DAMPPROOFING AND WATERPROOFING - Study Guide and Checkup

Study Guide

After you have studied the material in the workbook, complete the following exercises:

1. List five safety factors to check on a scaffold.

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

2. List six conditions under which waterproofing should be done.

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

3. List six conditions under which dampproofing should be done.

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Waterproofing may be needed on both below- and above-grade structures. 1. T F
2. Dampproofing may be needed on both below- and above-grade structures. 2. T F
3. Showerpan installation is a form of waterproofing. 3. T F
4. Two coats of asphaltic emulsion on a waterproof wall constitutes waterproofing. 4. T F
5. Asphalt-saturated fiberboard is part of a waterproofing membrane. 5. T F
6. Pitch coating, when cooled, will become more brittle than low-melt asphalt. 6. T F
7. High-melt asphalt is the best to use in cold climates. 7. T F
8. Flashing compound is used for foundation waterproofing. 8. T F
9. Planter boxes require different waterproofing principles than are required for basements. 9. T F
10. Waterproofing may be done to keep water either in or out of a structure. 10. T F

unit

b

Composition Shingling

TOPIC 1--SAFETY ON STEEP ROOFING

This topic, "Safety on Steep Roofing," is planned to help you find answers to the following questions:

- How can the inherent dangers of "high work" be effectively reduced?
- What roof pitch is considered "steep" for walking?
- What is the safest way to walk on a roof?
- If falls should occur on a steep roof, what action can be taken to prevent serious injury?
- What are ladder jacks, and how are they used by the roofer?
- When must a scaffold be used by the roofer, and who generally erects it?

Working high off the ground is an essential part of the roofing trade. Any apprentice roofer who has a fear of height should choose another occupation. Even though "high work" seems to carry with it certain dangers, it need not be dangerous if all established safety rules are observed. A thorough study of this topic may help to avoid a serious injury at a later date.

It is never advisable for any person, even though he may be used to high work, to work on a roof or scaffold when he is not feeling well. There may also be occasions when emotional strain makes it advisable to stay on the ground. In any event, steep roofs should never be climbed on unless the correct equipment is available and the roofer has the knowledge and training to use such equipment effectively. Even with correct safety equipment in use on the job, the roofer should remember at all times a cardinal rule for all high work: "Keep your mind on the job--don't let it wander off to other problems!"

Roof Pitch

A roof with a pitch over 8" in 12" is considered steep for walking upon, but it is not considered unsafe so long as the surface provides sufficient traction against the roofer's shoes to prevent slipping. Even roofs with less pitch may be considered dangerous if the roof is wet or covered with dust, moss, or any other substances that may act as a lubricant to overcome friction.

Wearing shoes with leather soles and heels on a roof constructed of dry wooden shingles is an extremely hazardous practice and should not even be attempted on roofs with a pitch even as low as 3" in 12". Gripper-type, rubber-soled tennis shoes are most satisfactory when shingling a steep roof, but proper roofer's shoes for each purpose should be worn at all other times.

When a roofer walks on a steep roof, he should always place the entire surface of his foot down upon the roof and stand erect (Fig. B-1). If the roofer leans forward toward the peak of the roof, the weight of his body is thrust downward, and the heels of his shoes normally lift off the roof, reducing the traction to less than one half of what it was.

If one should fall on jobs where no hot asphalt is being used, he should lie flat with arms and legs outstretched. This position provides the maximum resistance to slipping and rolling. When a fall occurs on a job where hot asphalt is used, however, it is best to sit up with hands off the deck in case the hot asphalt is encountered. (A light sprinkling of asphalt on a steep wooden deck will provide good traction on warm days.)

The effect of walking parallel with the slope of a roof is illustrated in Fig. B-2. Note that the lower foot assumes the major portion of the body's weight; therefore, one should always secure good footing with this foot and keep the other always ready in case of slips.

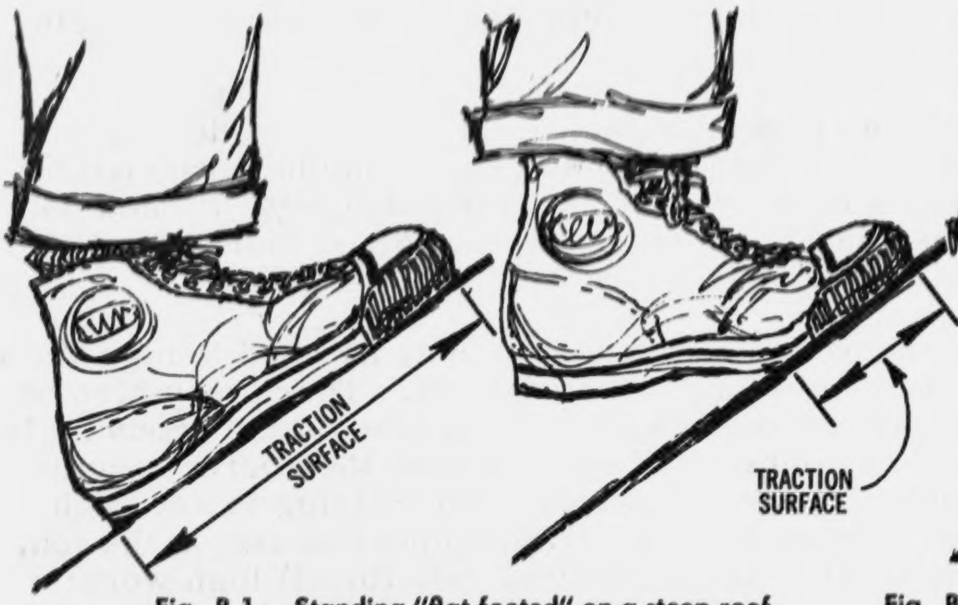


Fig. B-1. Standing "flat-footed" on a steep roof adds to surface traction

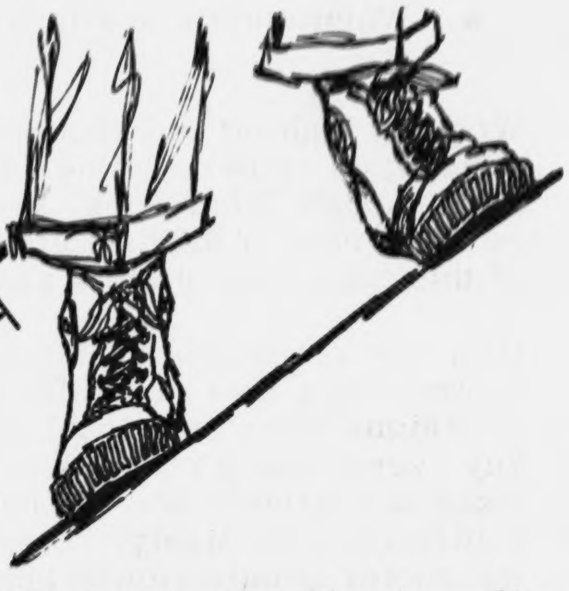


Fig. B-2. Correct position of feet when walking parallel with the slope of a roof

Chicken Ladders

A chicken ladder (or "cleat ladder," as it is sometimes called) is sometimes used on steep roofs as a safety device for walking. Such ladders are also used in some cases to protect the roof surface against damage from foot traffic. Chicken ladders are usually made by nailing wooden cleats at regular intervals of about 12 in. on a 15 or 20 ft. plank. At one end of the plank, and on the side opposite the cleats, is nailed a short piece of lumber -- usually a 2" x 4" or 4" x 4" -- as illustrated in Fig. B-3.

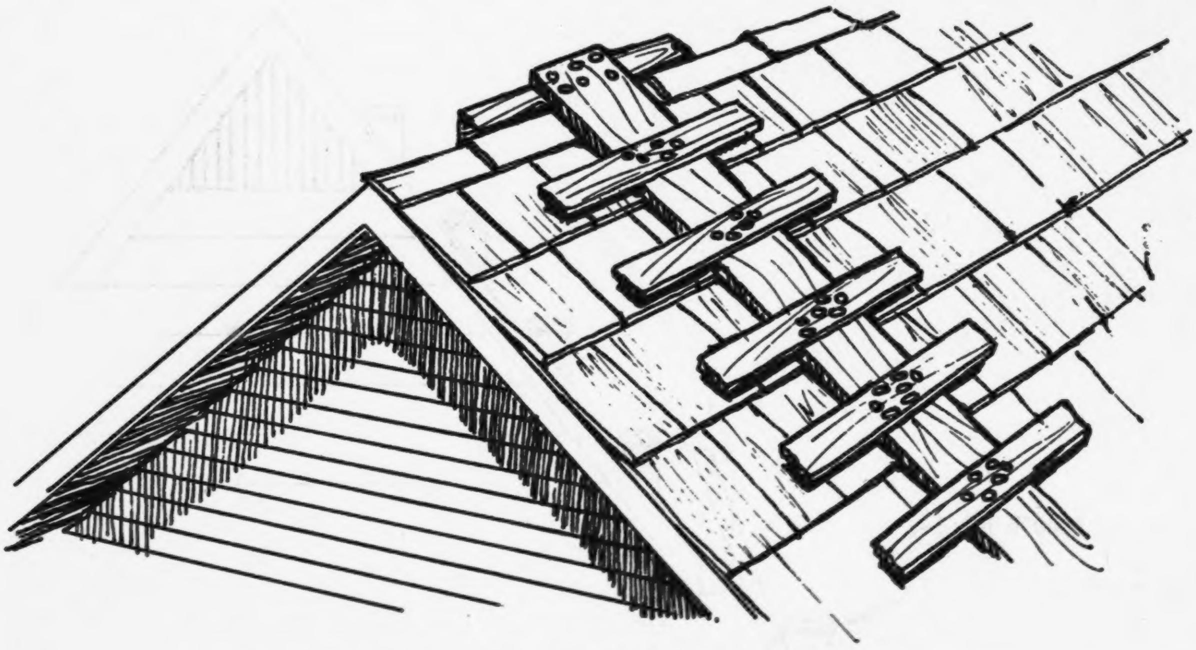


Fig. B-3. Construction of a typical chicken ladder

Chicken ladders are light in weight, yet awkward to handle because of their length. They are placed in position by hooking the top cleat, or hook, over the ridge. This is accomplished by sliding the ladder up the roof from the eave until it passes the ridge. It can then be hooked over the ridge by giving the ladder a slight downward pull. (Caution: Always test the ladder first by pulling on it as hard as possible. Do this after it is hooked on the ridge, but before climbing on it.)

Roof and Ladder Jacks

When shingling on a steep roof, a roofer nails the first two courses in place while standing on a plank supported by two ladder jacks. (See Fig. 50, p. 75, Roofing, Part 1.) The roofer next nails jacks (sometimes called roof brackets) not more than 10 ft. apart and in such position that they do not interfere with the next course of shingles. (See Fig. 47, p. 74, Roofing, Part 1.) Planks are placed upon the roof jacks to become the "platform" from which the roofer will work. (Caution: Care must be taken to see that the planks are of the right size and of such quality that they will support the load they will be required to carry.)

The roofer shingles up as far as he can conveniently do so, then nails on another set of jacks (Fig. B-4). This process continues until the roofer has reached the ridge. When the job is completed, the roof jacks should be removed, starting from the top of the roof and working down. The jacks can be removed with a slight push upwards and sideways. (See Fig. 48, p. 74, Roofing, Part 1.) It is only necessary to leave enough jacks and planks in place to provide access to the roof until the job has received its final inspection.

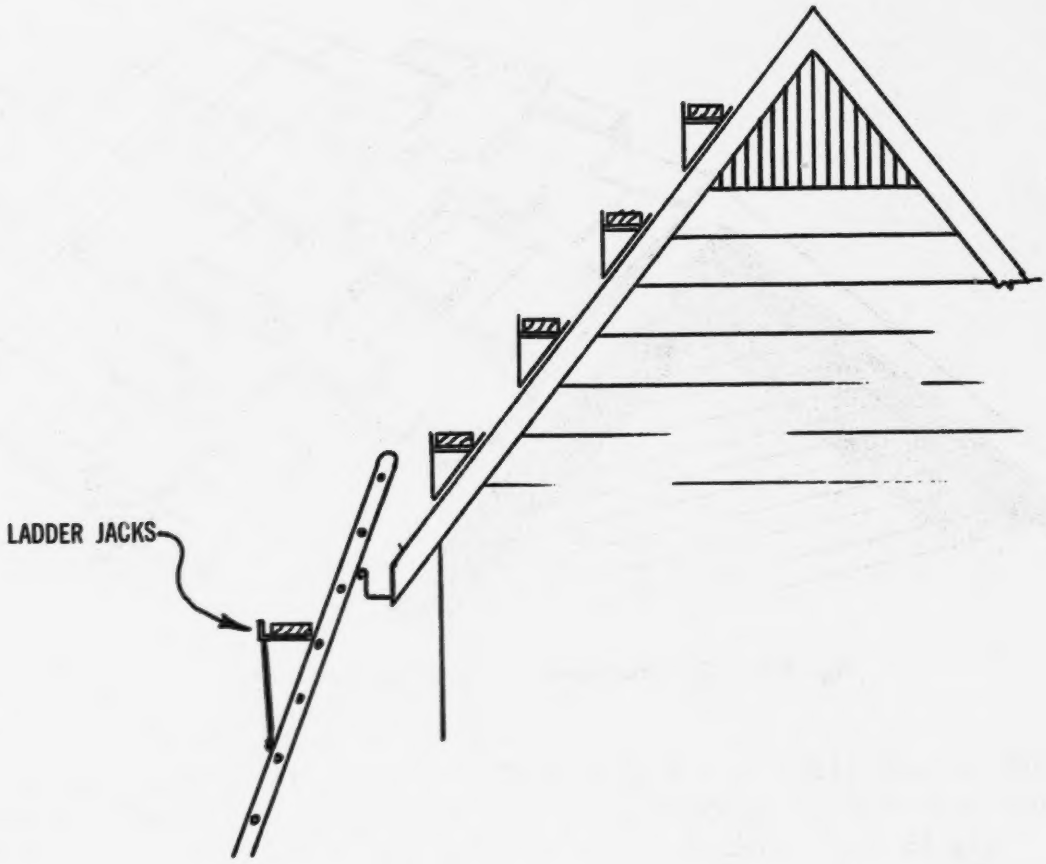


Fig. B-4. Typical placement of ladder and roof jacks

(Note: Roof jacks should be secured to the roof with nails no smaller than 16 penny. Nails must be driven into a solid base, such as a rafter.)

Scaffolding for Roofing

It is sometimes necessary to install scaffolding when working on spires or other roof surfaces too steep to accommodate roof jacks. Scaffolding is also used when siding is installed. Such scaffolding is usually erected by the general contractor on new jobs, or it may be done by a scaffolding company on repair and recover work.

Boatswains' Chair and Hand Line

Boatswains' chairs may be used for minor repair work on spires and other extremely steep (nearly vertical) surfaces when access is not possible in any other way. A sling is used for temporary traverse or for safety purposes. The main factor to consider when using such equipment is proper anchoring of the loose end of the line.

Working on steep roofs and on high work of any kind frequently requires the use of hand and safety lines. Consequently, a good knowledge of and skill in tying knots is essential to the roofer's safety. The knots illustrated in

Construction Safety Orders should be studied and practiced by every roofer until the correct tying and use of these knots becomes second nature.

The best way to learn how to work on steep roofing is to gain experience by working with an experienced journeyman roofer who is familiar with all the processes and safety requirements involved.

Slipping on Asphalt

The danger of slipping is always present when one works around asphalt. Generally speaking, slips under these conditions are caused by the following actions:

1. Stepping directly on hot asphalt
2. Stepping on a sheet of roofing freshly laid in hot asphalt
3. Walking on a wet glazed surface
4. Walking without due caution on a cold glazed surface
5. Wearing shoes not proper for the job

Safety Note: When "glazing in," always keep water in a clean bucket. If water is kept in a "hot" bucket, it is too easy to confuse this with a bucket actually containing hot asphalt. Because of this confusion, many a roofer has accidentally put his hand into a bucket of hot asphalt when he thought it was a bucket of water.

Study Assignment

Construction Safety Orders. Sacramento: Division of Industrial Safety, California State Department of Industrial Relations, 1965, Sections 1636-52, 1669-72 and 1725-26; and pp. 34-29 to 34-33 and 34-47.

UNIT B--COMPOSITION SHINGLING

TOPIC 1--SAFETY ON STEEP ROOFING

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. A safe means of fastening together the ends of two ropes of equal diameter is a square knot. — 1. T F
2. The minimum size plank to use when working on a roof with a 4" in 12" pitch (or greater) is a 2" x 8". — 2. T F
3. The use of roof jacks is required for all roofs with a pitch greater than 6" in 12". — 3. T F
4. Construction Safety Orders are rules made up by the general contractor. — 4. T F
5. Rubber-soled tennis shoes are not recommended for wear when working on steep roofs. — 5. T F
6. The best wood to use for planks on roof jacks is fir or cedar. — 6. T F
7. Roof jacks may be nailed no more than 12 ft. apart. — 7. T F
8. Roof jacks may be secured with 8 penny nails. — 8. T F
9. A shingler's bracket and plank are used only for a toe hold. — 9. T F
10. Ladder hooks are used primarily for very steep roofs — 10. T F
11. The use of a boatswains' chair is restricted by the Construction Safety Orders to towers and cones. — 11. T F
12. Chicken ladders are attached to regular ladders on the last three rungs. — 12. T F
13. Cleat ladders are fastened on to the gables of a roof. — 13. T F

14. High work need not be dangerous if safety rules are observed.	14. T F
15. The most important safety item on steep roofing work is surface traction.	15. T F

UNIT B--COMPOSITION SHINGLING

TOPIC 2--ROOF PREPARATION

This topic, "Roof Preparation," is planned to help you find answers to the following questions:

- What should be looked for when inspecting an old or new roof prior to reroofing with composition shingles?
- How can a roofer determine whether an old roof should be removed prior to reroofing?
- How are the correct shingles selected for a job?
- What are the advantages and disadvantages of composition shingles?
- What is the correct way to load a roof with bundles of asphalt shingles?

The application of a shingle roof should be looked upon as a work of art. The general appearance of a customer's home (or an entire neighborhood, for that matter) depends to a large extent on the skill and ability of the roofer. On a conventional residence with a pitched roof, every shingle shows; it is therefore essential that all horizontal, vertical, and diagonal lines caused by the application of shingles be kept straight and parallel.

Composition Shingles

Composition (or asphalt) shingles are one of the most popular types of roofing materials. They are adaptable to almost any kind of building with an adequately pitched roof, and they are used extensively in reroof jobs on older homes. The composition shingle is truly an American product and is used in all parts of the United States, Canada, and Mexico.

The method of application varies throughout the country because of different climatic conditions, but once the roofer learns the basic principles involved, he will have no trouble adapting them to local situations.

Asphalt shingles have many advantages. Among them are the following:

- A large number of styles, shapes, and designs
- Extensive color selection, including blends and artificial shadow lines
- Excellent characteristics for recover purposes (It is not necessary to remove old composition shingles unless required by local building code.)

- Will not curl or buckle if properly installed
- An economical roofing material for any job

Like any other product, asphalt shingles also have disadvantages. Among these are the following:

- They do not obtain the true, bold shadow line, an effect desired by some architects and customers.
- Precautions must be taken to ensure tight application in windy areas, for they have a tendency to lift and blow off. (This problem is partially solved in the "seal down" shingle.)
- They can be punctured during severe hail storms.

Inspecting and Preparing the New and Old Deck

(Review Unit D, Topics 1 and 2, Roofing, Part 1. This information applies to asphalt shingle roofs.)

Old Roofs

When the roof framing is not sufficiently strong to support the additional load of new roofing (that is, when three or four roof applications have already been made), the structure should either be reinforced or the old roofing removed. Most modern structures are designed to withstand a dead load of 15 to 20 lbs. per square foot, and such a structure will support two or three roof applications before it becomes necessary to remove the old roofing prior to the application of the new. This factor should be considered when estimating the cost of a reroofing job.

Wood shingle roofs quite often are deteriorated to the point where they will no longer hold nails. In these cases, it is wiser to remove the shingles and prepare the deck to accept the asphalt shingles.

In this regard it must be remembered that on very old houses with wood shingle roofs, the shingle lath or sheathing may be narrow and widely-spaced. Because of this the nails used on the reroofing operation may penetrate a board only occasionally, making for a very weak job. Under these conditions, asphalt shingles can be blown off easily in a high wind. It is best to check the sheathing spacing and prepare appropriate recommendations for correction.

The general procedure for reroofing with asphalt shingles over old wood shingles is as follows:

- Remove all hip and ridge shingles.
- Nail down all high "curls" or rough shingles. This may be done while the new roof is installed.

- Drive in all nails that protrude from the old shingles.
- Remove all shingles or sheathing affected by dry rot and replace with new materials. (Dry rot conditions are generally found along the eaves.)
- Install metal edging if required or if specified.
- Sweep the old roof, removing all old dirt and debris.
- Fill in all holes and replace missing wood shingles.

Loading the Roof

Shingle bundles should never be dropped upon the roof, and the roofer should walk upon the roof carefully to avoid damaging the plaster inside the house. (Review Unit B, Topic 3, Roofing, Part 1.)

Shingles should be hoisted and carefully placed on the roof, spaced along the hips and ridges. When placing the shingles, the roofer should estimate the number of squares on each section of the roof and distribute the bundles accordingly.

The approximate amount of material required for valleys, starter strips, hips and ridges, and metal edging should also be hoisted and placed on each portion of the roof where required. This should be done in such a manner that the material will not be in the way during the installation process, which would require double handling.

Preparation for installation on masonry and stucco walls and wooden siding. (See Unit D, Topics 1 and 2, Roofing, Part 1.) Much of this information applies to shingling.

Study Assignment

J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products, pp. 11-17 and 20-24.

UNIT B--COMPOSITION SHINGLING

TOPIC 2--ROOF PREPARATION - Study Guide and Checkup

Study Guide

After you have studied the material in the workbook and the assigned material, complete the following exercises:

1. List five things to look for when inspecting a new roof prior to the application of composition shingles:

   (1) ____________________

   (2) ____________________

   (3) ____________________

   (4) ____________________

   (5) ____________________

2. List five things to look for when inspecting an old roof prior to the application of composition shingles:

   (1) ____________________

   (2) ____________________

   (3) ____________________

   (4) ____________________

   (5) ____________________

3. Name the two basic kinds of asphalt shingles and the different types of each:

   (1) ____________________

      (a) ____________________

      (b) ____________________

   (2) ____________________

      (a) ____________________

      (b) ____________________

4. List five things that must be considered when applying an asphalt shingle roof in windy country:

(1) ______________________________
(2) ______________________________
(3) ______________________________
(4) ______________________________
(5) ______________________________

5. List three conditions when an underlayment should be used for an asphalt shingle roof:

(1) ______________________________
(2) ______________________________
(3) ______________________________

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. A Dutch lap shingle gives better coverage than any other kind.	1.	T	F
2. "Shingle lath" and "roof sheathing" are the same.	2.	T	F
3. Metal edging is used on the rakes of an old wood shingle roof only to hide the unsightly ragged edges.	3.	T	F
4. A quality reroof job on a wood shingle roof with two existing layers of asphalt shingles would require the removal of all the old shingles and replacement of the deck.	4.	T	F
5. One of the main objections to composition shingle roofs is they do not have a "bold" appearance.	5.	T	F
6. Most residential roofs are strong enough so that bundles of shingles may be dropped on them with no danger of damage to the interior of the building.	6.	T	F
7. Composition shingles are among the most popular roofing materials.	7.	T	F
8. The method of applying asphalt shingles does not vary with prevailing weather conditions.	8.	T	F

9. If a roof structure is already burdened with maximum shingle weight, it can be reinforced before another roof is applied. 9. T F

10. For the sake of appearance, more care must be taken in the application of a shingle roof than on a flat, built-up job. 10. T F

11. Roll roofing, cut in shingle design, is considered to be shingles. 11. T F

12. Hexagon shingles weigh 167 lbs. per square. 12. T F

13. On Dutch lap shingles, the side lap is 3 in. and the head lap, 2 in. 13. T F

14. The best practice when loading a roof is to put all the shingles in one spot to keep them out of the way while the installation is being done. 14. T F

15. Composition shingles have many advantages over other types and practically no disadvantages. 15. T F

UNIT B--COMPOSITION SHINGLING

TOPIC 3--PRELIMINARY INFORMATION ON SHINGLING

This topic, "Preliminary Information on Shingling," is planned to help you find answers to the following questions:

- What are the advantages and disadvantages of a composition shingle roof?
- Under what conditions will a composition shingle roof deteriorate rapidly?
- What weather element takes the greatest toll on a shingle roof?
- What is the effect of roof insulation on the roofing material used?
- What effect does color have on the longevity of an asphalt shingle roof?
- What does roof pitch have to do with wind damage on a roof?

Because of the trend in recent years toward "mass production" in house construction, the roofing trade has begun to lean toward specialization; that is, some roofers are specialists in built-up roofing, others in shingling. Although such specialization has some advantages, particularly in the way of high unit production, it also has some disadvantages, especially for the roofer. A man who is highly skilled in one phase of roofing, but not in another, may find himself out of work simply because the type of roof he specializes in is not being done at the moment. Therefore, a roofer, for his own welfare, should be proficient in all phases of roofing. This topic deals specifically with certain characteristics of composition shingles; such information is valuable to the apprentice who will be developing skills in applying this kind of roofing.

Characteristics of Composition Shingles

To understand the advantages, disadvantages, possibilities, and limitations inherent in composition shingles requires study that goes beyond what may be learned on the job. Laboratory research testing provides much information essential to the roofer so that he may select and apply a composition shingle roof properly. Among the points to keep in mind when preparing to apply asphalt shingles are:

- Roofing applied over a wet deck will incur more leaks than if applied when the deck is dry because lumber shrinkage and warpage often cause the roofing to split. Good ventilation helps prevent deck boards from warping, rotting, or shrinking. Plywood decks are not as susceptible to this problem.

- Roofing laid over an insulated deck will deteriorate more rapidly than would otherwise be the case because the roofing material will retain heat for a longer period of time, since the heat cannot be transferred to the deck below. This heat causes rapid evaporation of the oils in the asphalt, shortening the life of the roof.
- Wind pressure under a deck will often blow off or crack the roofing.
- Light-colored roofing will last longer than dark-colored roofing of the same quality because dark colors absorb more heat.
- Even though "seal tab" or interlocking shingles have a high resistance to wind, they are still vulnerable.
- Heavy shingles withstand wind best.
- The best cohesion takes place when tabs are sealed during warm weather (over 70° F).
- Underlayment helps prevent shingles from lifting in the wind.
- The steeper the pitch of a roof, the less vulnerable are shingles to wind damage and the longer the roof will generally last. (See Fig. 7, p. 19, in the assigned reference.)
- Proper nailing is essential to long roof life.
- Double coverage shingles are better than single coverage.
- The flatter the roof, the more apt it is to leak.
- Roofs always covered with leaves or dust, or exposed to prolonged dampness causing moss to grow, will deteriorate rapidly.
- Roofing material to be used on roofs exposed to corrosive factory processes should be chosen carefully with this particular hazard in mind.

Study Assignment

J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products, pp. 17, 19, 21-27, 30-39, and 45-46.

UNIT B--COMPOSITION SHINGLING

TOPIC 3--PRELIMINARY INFORMATION ON SHINGLING - Study Guide and Checkup

Study Guide

After you have studied the material in this topic and the assigned material, complete the following exercises:

1. Describe the three steps to take when flashing composition shingles to an existing stucco wall:

   (1)

   (2)

   (3)

2. What is the best way to flash a composition shingle roof to wooden siding on new construction?

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Heat keeps asphalt soft and durable. — 1. T F
2. An insulated roof prolongs the natural life of the roofing material. — 2. T F
3. Wind destroys asphalt shingle roofs more rapidly and more frequently than any other element. — 3. T F
4. The main purpose of a metal drip edge on a roof is to prevent the rotting of wood at the eaves. — 4. T F

5. Starter strips are a form of flashing. 5. T F

6. Starter strips are placed under metal drip edges. 6. T F

7. Counterflashing goes over the turned-up shingle. 7. T F

8. Metal counterflashing on a chimney fits into a reglet. 8. T F

9. There are five ways to flash a chimney. 9. T F

10. The terms "cricket" and "saddle" mean the same when applied to a chimney. 10. T F

11. Light colors absorb heat; dark ones relfect heat. 11. T F

12. When flashing walls and chimneys, the roofer should always work from the highest point downward. 12. T F

13. If a wood shingle roof with one existing layer of composition shingle is to be reshingled with composition shingles, 1 3/4-in. nails should be used for the job. 13. T F

14. A 1-in. nail should be used to apply a composition shingle roof over a 3/4-in. exposed porch V-joint deck. 14. T F

15. The steeper the roof pitch, the more chance wind has to destroy the shingles. 15. T F

UNIT B--COMPOSITION SHINGLING

TOPIC 4--APPLICATION OF ASPHALT SHINGLES

This topic, "Application of Asphalt Shingles," is planned to help you find answers to the following questions:

- What is the correct nailing procedure to follow when applying asphalt shingles?
- What are the major differences between various types of asphalt shingles?
- How is the correct shingle selected for a specific job?
- How are valleys laid with shingles, and how many methods are generally used?
- How are shingle joints "broken"?

Shingling practices differ throughout the country because of varying weather conditions. Consequently, this topic deals with the application of asphalt shingles under all conditions.

Shingles with lock tabs and adhesives for use on tabs are designed for use in areas where strong winds prevail. Special "heavy" shingles are produced for use on public buildings and factories. Double-coverage shingles are those with an extra coating of asphalt and mineral coating on the butts (thick butt shingles) and can be considered the "quality" shingle, while the thinner, single-coverage shingles are used most where price competition is an important factor.

Covering Valleys

There are three standard methods of covering a valley: open, closed, and half-open (or half-lapped). Of the three, the half-open method is the most popular. It is also easy to construct and, therefore, economical.

The Half-open Valley

An 18-in. strip of capsheet is centered in the valley over the previously-installed underlay. The shingles are then laid on an entire side (or slope) of the roof, covering the valley sheet and extending at least 12 in. up the opposite slope. A chalk line is then snapped down the center of the valley, and a bleeder strip is laid parallel to this line on the unshingled slope side (Fig. B-5).

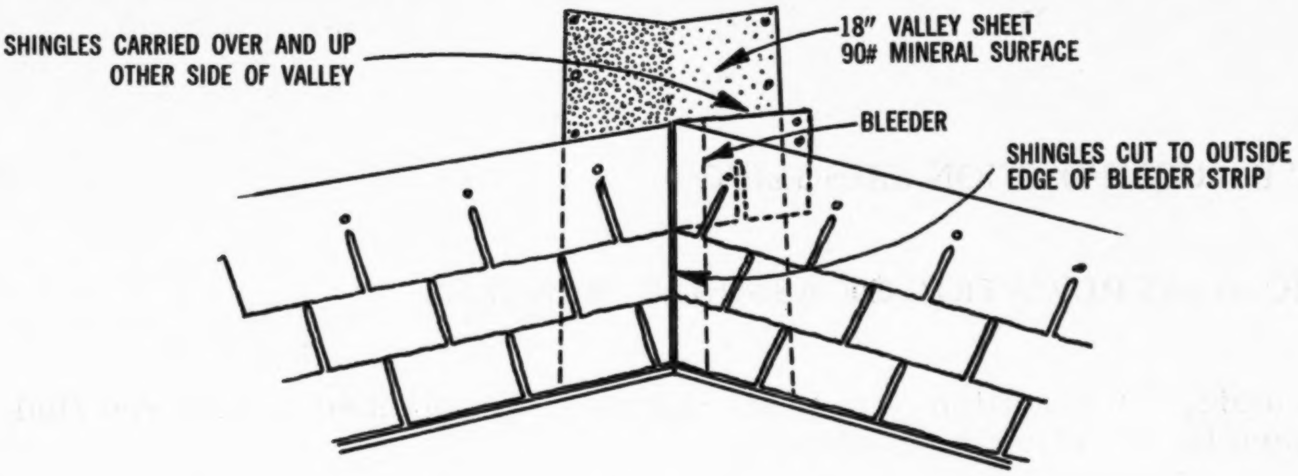

SHINGLES CARRIED OVER AND UP OTHER SIDE OF VALLEY
18" VALLEY SHEET 90# MINERAL SURFACE
BLEEDER
SHINGLES CUT TO OUTSIDE EDGE OF BLEEDER STRIP

Fig. B-5. Installation of the "half-open" valley

Shingles are now laid on the second slope, with the top corner of each valley shingle extending to the chalk line (or the edge of the bleeder strip). Each shingle thus laid is then cut parallel to the chalk line, from top to bottom. (The bleeder strip edge provides an excellent cutting guide for this operation.) The final effect is shown in Fig. B-5.

The visual result of using this method is a "woven" effect that still offers a straight, bold line down the center of the valley. This line gives depth and a definite outline to the valley as well. This type of valley may be made with all types of shingles.

Shingling on Dormers and Roof Intersections

When valleys formed by dormers, or any other intersecting roof, occur in the field of the roof in such a position as to break the field into two large sections, certain problems are presented. This is an area where the roofer's skill can best be demonstrated.

A problem exists in that the two sections of roof must be laid out independently, yet the shingles must meet each other with precision at the ridge of the intersecting roof. It is necessary, therefore, to chalk line the roof and lay the shingles to the line.

One side of the roof is laid and the shingles are run up the valley, with those in the top course permitted to run over the head of the valley. A chalk line is then snapped across the roof on this top course which is parallel to the ridge or eave (Fig. B-6).

Measurements in the area of the center and lower end of the valley are taken on the shingles already laid, and these measurements are transferred to the roof field not yet shingled, and chalk-lined (Fig. B-6). Measuring on the top course from the end of the last full shingle laid to a point that will clear the lower end of the valley, the roofer should strike a chalk line perpendicular to those already made. These vertical and horizontal lines are sufficient to keep the shingle in perfect alignment on both fields.

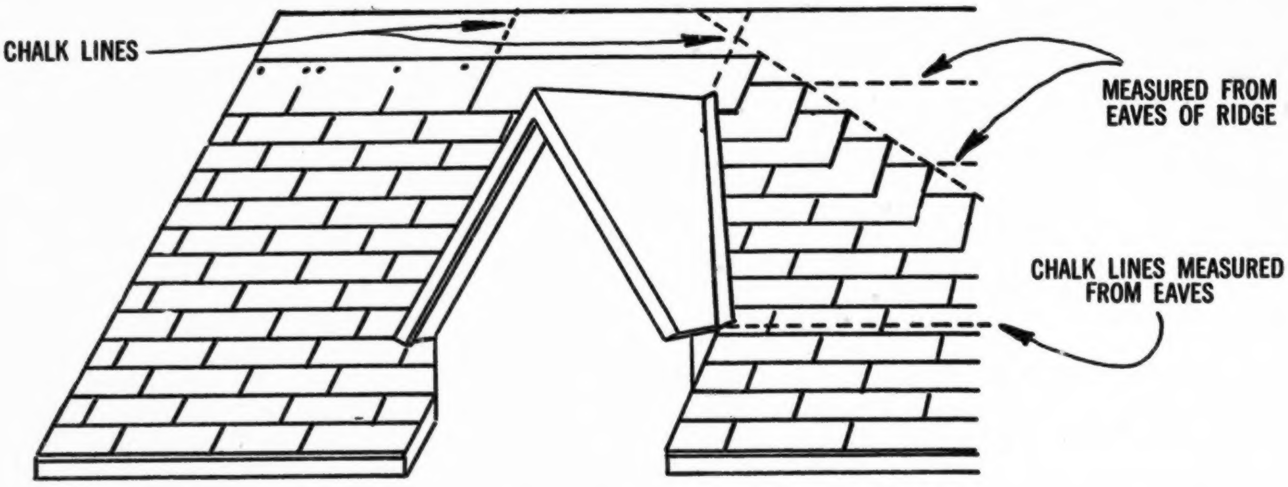


Fig. B-6. Shingling procedures on dormers and intersections

Correct Nailing

Anchoring shingles securely to the roof is essential to a good job. This is especially important along eaves and rakes, as these are the areas most susceptible to wind damage. Following is a list of pointers to keep in mind when nailing a shingle roof:

- Always use the right length of nail for the job. Make sure nails are not so long that they penetrate through an open eave or ceiling.
- Always nail from the center out or from one end to the other. Never nail both ends of a strip shingle first, and then the center.
- Line up the shingle correctly before nailing. Be sure the shingle is lying flat on the roof.
- Drive all nails in straight.
- Nails should never be driven so far in that the shingle is cracked or broken. (Any shingle so broken should be replaced.)
- All nails should be spaced correctly.
- If a nail is driven into a sheathing board crack, another nail should be driven in farther up on the shingle.
- Always use galvanized, aluminum, or rust-resisting nails.

Study Assignment

J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products, pp. 38-65, 70, and 73-74.

UNIT B--COMPOSITION SHINGLING

TOPIC 4--APPLICATION OF ASPHALT SHINGLES

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. On a shingling job, if a nail misses a sheathing board, no corrective action need be taken, since it may be assumed that the other nails used will hold the shingle adequately. 1. T F

2. The term "joint breaks" refers to cutting the shingles to the desired spacing or pattern. 2. T F

3. The main purpose of using ribbon courses is to ensure a more waterproof roof. 3. T F

4. Giant Dutch lap shingles are double coverage. 4. T F

5. Individual large hex shingles are single coverage. 5. T F

6. Hex strip shingles are single coverage. 6. T F

7. Square butt strip shingles are single coverage. 7. T F

8. Hex strip shingles have a longer life expectancy than individual hex shingles. 8. T F

9. Underlayment is used as a protective device mainly on roofs with a pitch of less than 4" in 12". 9. T F

10. Blind (or closed) valleys are generally preferred over all other types. 10. T F

unit C

Rigid Roofing

TOPIC 1--TILE TYPES, STACKING, AND LOADING

This topic, "Tile Types, Stacking, and Loading," is planned to help you find answers to the following questions:

- How many types of roofing tile are there?
- What is the main difference between plain tile and interlocking tile?
- What are some of the standard tile tests?
- Why are custom tile designs sometimes required, and when are they generally used?
- What are the recommended procedures for stacking and loading tile?

Perhaps more roofs throughout the world are covered with tile than with any other type of roofing material. The universal availability of tile, its ease of fabrication, and its excellent durability in all climates probably accounts for its popularity. No one really knows where or when clay tile was originated. Although early tile was undoubtedly sun-dried and, therefore, easily destroyed by weather, ample evidence exists that indicates tile in some form was used by the Greeks and Romans in ancient Europe and by the Japanese and Chinese in Asia.

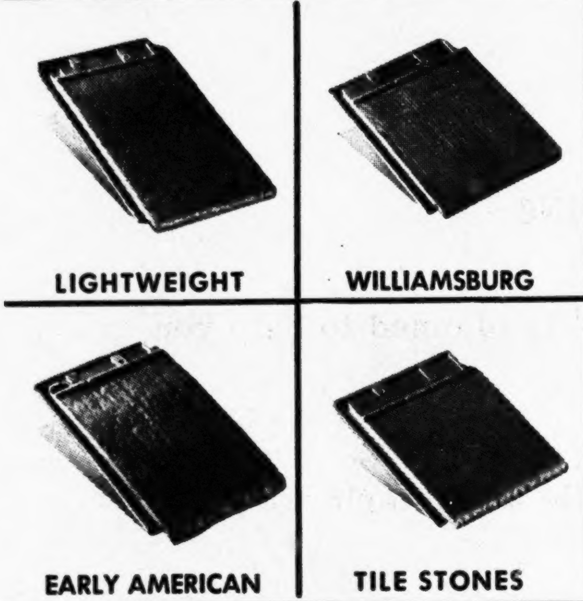
Tile played a major role in roofing during early California history. Although missions were originally covered with straw roofs, these were soon replaced by tile roofs. The tile used was usually molded over an Indian's thigh or over a formed section of a log. Then the tile was allowed to dry out and was eventually fired in a kiln.

Although roofing tile is no longer used extensively in this country, most roofers will be called upon from time to time to work on a tile roof.

Tile Types

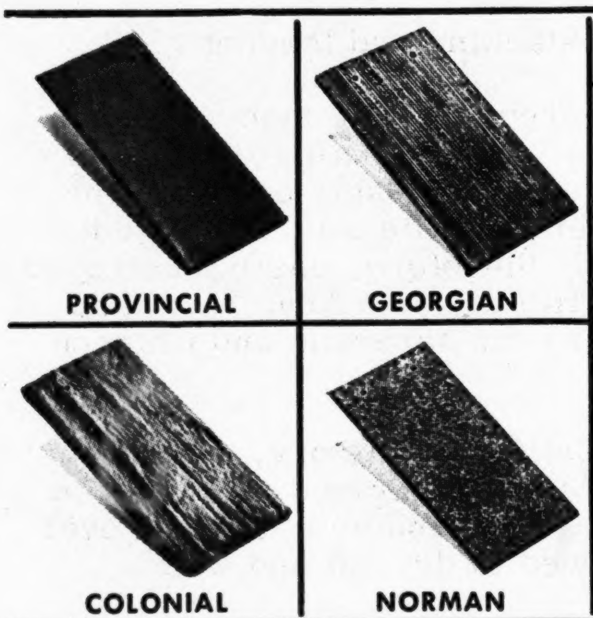
Hundreds of variations in tile design have been used throughout the years, some tile measuring as large as 2 by 3 feet. But tile generally can be classified into two main categories--shingle (or flat) tile, either plain or interlocking, and pantile. There are also combinations of these two. Pantiles may be interlocking, too, and are considered a single coverage tile. (See Roman tile, Fig. C-1.) The two most popular types of pantile used in the United States are the Spanish and the Mission (or "Barrel") tile. Most tile used today is made of cement or baked clay, but the latter is more prevalent because of its inherent strength and resistance to water.

INTERLOCKING SHINGLE TILES



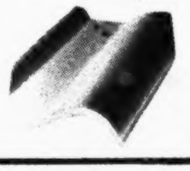
PATTERN	STANDARD SURFACES	STANDARD COLORS	AVERAGE WEIGHTS	AVERAGE EXPOSURES	
				WIDTH	LENGTH
LIGHT-WEIGHT	SMOOTH OR WEATHERED	BLACKS, BROWNS, GREENS, REDS	800 lbs. per sq.	7⅞″	10¾″
WILLIAMSBURG	ROUGH COMBED	GRAYS, GREENS	830 lbs. per sq.	8″	8″
EARLY AMERICAN	RUGGED GRAINED TEXTURE	GRAYS, GREENS	780 lbs. per sq.	7⅞″	10¾″
TILE STONES	STONE-LIKE TEXTURE	GRAYS, GREENS	800 lbs per sq.	8″	8″

TILE SHINGLES

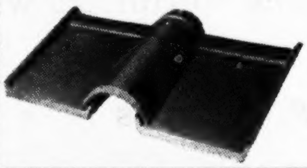


PATTERN	STANDARD SURFACES	STANDARD COLORS	AVERAGE WEIGHTS	AVERAGE EXPOSURES	
				WIDTH	LENGTH
PROVINCIAL	FINE SCORED OR WEATHERED	BLACKS, BROWNS, GREENS, REDS	1560 lbs. per sq.	7½″	6½″
GEORGIAN	ROUGH COMBED	GRAYS, GREENS	1500 lbs. per sq.	5″, 7″ or 8″	6½″
COLONIAL	RUGGED GRAINED TEXTURE	GRAYS, GREENS	1760 lbs. per sq.	7″	6½″
NORMAN	PITTED AND WEATHERED	GREENS, GRAYS, BROWNS, BLACKS	AVERAGE 1750 lbs. per sq.	7″	5″, 6″ or 6½″

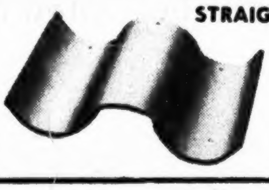
MISCELLANEOUS PATTERNS



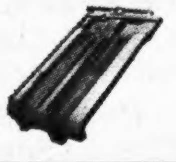
SPANISH
Exposure:
Width 8¼″
Length 10¼″
Weight:
900 lbs per sq.



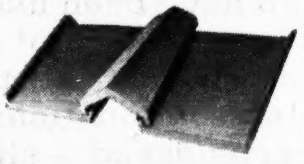
ROMAN
Exposure
Width 12″ O.C.
Length 10″
Weight:
1300 lbs per sq.



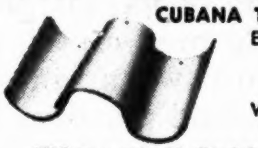
STRAIGHT BARREL MISSION
Exposure:
Width 11½″ O.C.
Length 11¼″ or
Width 11½″ O.C.
Length 15″
Weight:
1250 lbs. per sq.



FRENCH
Exposure:
Width 8⅛″
Length 13¼″
Weight:
940 lbs. per sq.



GREEK
Exposure:
Width 12″ O.C.
Length 10″ or
Width 19″ O.C.
Length 15″
Weight:
1350 lbs per sq.



CUBANA TAPERED MISSION
Exposure:
Width 11¼″ O.C.*
Length 15″
Weight:
1325 lbs. per sq.
*When used with Straight Barrel Pans.

Fig. C-1. Types of roofing tile

Interlocking Tile

Interlocking tile is designed with a series of tongues and grooves, which serve two purposes: (1) to provide a guide for accurate laying; and (2) to improve the weatherproof qualities of the tile by preventing "blowback" of water into the undertile membrane.

Roof layout must be precise when interlocking tile is used, so that the tile at rakes, walls, chimneys, and the like will come out even. Normally there is no more than an inch of leeway in twenty feet by squeezing or stretching the layout on a course.

Roofs on which tile is used must have enough pitch to permit proper drainage; otherwise, the water may run back under the tiles and cause leakage.

Tile Quality

Some tiles are stronger and less porous than others, depending on the quality of clay used and the way in which the tile is formed and fired. The clay used for tile is similar to that used in making brick, but is generally of higher quality. A large amount of clay tile is made in Southern California, but it is produced in other sections of the country as well. In addition, the United States imports tile from Mexico, Italy, Japan, Germany, and the Netherlands.

Tile Durability

Some tile roofs in many parts of the world are hundreds of years old and are still quite serviceable, although a number of the tiles have had to be replaced because imperfections caused them to deteriorate. A roofer soon learns to detect a defective piece of tile prior to installation, and such pieces are either discarded or saved for use on hips and valleys, where the tile may be cut. Tiles with hairline cracks will usually break in cold climes because of the expansion and contraction occurring during alternate freezing and thawing periods. Modern tile manufacturing techniques include a vacuuming process, which removes all air pockets, making the tile dense enough to withstand extreme temperature changes without cracking.

Architects sometimes prefer to use a light tile for reduced roof weight. To achieve this, a thinner tile is made--down to 1/2-in. where appropriate. If heavy roof traffic is expected, a 3/4-in. tile embedded in cement mortar, may be required.

Tile Tests

A single flat or shingle tile laid 10 in. on center should be able to withstand a weight load of 175 to 200 lbs. (Cement tile will not have this strength, especially if made with vermiculite.)

A typical building code requirement may read: "In the immersion test, tile should absorb not more than 15 percent water in 48 hours." (Cement tile made with a lightweight aggregate such as vermiculite may have a higher absorption rate; consequently, such tile must be waterproofed with a repellant or treated with a vinyl- or oil-based material.

Another test requirement might read:

> All curved, burned-clay roofing tile shall successfully meet the following test requirement: Each tile from a group of five tile selected at random from the field shall be laid with the crown (or convex) side up across two bearings 12 in. apart to make a clear span of 12 in. A concentrated load shall then be carefully applied at the crown at its center or mid-span. This load shall be increased slowly to the destruction of the test sample. In no case shall any individual tile fail or fracture under a test load which is less than 350 lbs., and the average destruction load for the five samples tested shall not fall below 400 lbs.

Tile used for roofs is generally unglazed, therefore only water resistant. Because of this, an underlayment (or undertile membrane) is used with tile. High-quality tile has a proportionally higher water resistance, and glazed tile is considered waterproof.

Tile Colors

Tile color is generally that of the natural baked color of the clay used in its manufacture. "Variegated" tile is sorted and stacked at the tile plant to give a pleasing variety and distribution of tones. Such tile is more costly, of course, but is often preferred by the architect or builder. The tone variation is obtained during the process by varying the baking time. Conversely, uniform colors are obtained by glazing the tile prior to baking and then firing at 1800° F.

Custom Tile Designs

Tile may be custom-designed and manufactured for a special job; for example, a conical tower roof. In cases such as this, each tile is numbered according to its designated location on the roof; for example, going from wide tile at the eave of the roof to progressively narrower tile toward the ridge or peak.

In addition, a number of specially shaped pieces may be manufactured to serve specific functions. These may include ridge, hip, and valley tiles, which often are a different size or shape than the field tiles. These special tiles must be made to fit over the field tiles and can be made to fit the various angles found in ridges and hips.

Special rake tiles are made to give a finished edge on the rakes of a roof, and these are designed for both the right and the left rake.

"Bird stops" or eave closures are made to close the ends of tiles located on the eaves of a roof. Sometimes special field tiles are used for this purpose, and these are simply field tiles with one closed end.

Eave, or starter, tile (also called "boosters") are often used on a roof eave before the first course of regular tile is laid. They can also be used at random in the field to create an irregular pattern. These tiles are usually 4 in. in length and, when used under another tile, "boost" the low end of the tile to create a slight flare for the sake of appearance. In boosting the low end, however, the high end of a tile is lowered, allowing a better fit for the next course of tile.

Another special tile is sometimes used for coping on parapet walls, but special coping tiles are also made. These tiles are frequently glazed to make them waterproof, since they serve as small roofs on masonry parapet walls. (Coping tile may also be called "flashing.")

Loading Tile

In the loading of a roof, roofing materials should always be placed where there is sufficient support to carry them, but this is especially true of tile since it is so heavy. It is a good practice when on a tile job to inspect the underside of the roof structure to locate the relative positions of main support beams and posts. Insofar as possible, tile should be stacked over such members, as well as along ridges and hips (Unit B, Topic 1, Roofing, Part 1). No stacking should be done in valleys because these areas are generally the weakest part of a roof. The weight problem is negligible on class A structures because these are usually strong enough to withstand normal loading stresses almost anywhere on the roof.

Tile weight per square is from 750 to 1,800 lbs., depending on the type. It is sometimes necessary, therefore, to increase the structural strength of a roof prior to the application of tile. The need for additional strength is usually obvious; for example, a roofer should never attempt to lay tile on a roof that was first covered with wood or asphalt shingles, since such shingles weigh only about 150 lbs. per square. It should be noted, too, that a tile roof may increase in weight from 15 to 100 percent when saturated with water.

Tile should not be stacked on a roof in the manner of asphalt shingles, that is, several rows deep. Instead, small groupings should be distributed over the entire roof. To avoid slippage, tile should be stacked at right angles to the ridge of the roof.

Various types of tile should be kept in separate groups--rake, eave, field, and so forth. They should be so placed as to be readily accessible to the place where they will be used.

Only an experienced tile man can load a complicated roof in the correct manner. The apprentice can gain this knowledge from the journeymen on the job and from this topic. On a simple shed or gable roof the job is not complicated, but when a variety of tile types is being used, layout will depend on such considerations as sequence of loading and proper placement of tile types. (Proper loading and placement of tile is described in further detail in the following topic.)

Walking on Tile

An experienced tile layer, using an "eggshell step," can walk over a tile roof without causing any damage, but precautions should usually be taken. Among the things that can be done to protect roof tile from damage are the following:

- Fill small burlap sacks with wood shavings or sawdust. Throw these bags ahead of you to walk on. These bags tend to distribute your weight over three or four tiles.
- If not using the burlap bag technique, walk on two tiles at a time, rather than just one. A careful step requires a knowledge of how tiles are laid. Always step on the outer ends of a tile--never in the center.
- If you must do extensive walking, place sacks of wood shavings (or sawdust) under the two ends of a plank and use the plank as a catwalk. Cemented hips and ridges also offer a safe route to follow.
- If necessary, lay a single course or path of tiles in cement to provide a safe access route.

Safety note: Never attempt to stand a ladder directly on tiles. A ladder thus situated can slip too easily, and too much weight is concentrated on each ladder leg. Use sacks of wood shavings under the ladder instead, making sure the ladder footing is completely solid.

Handling Tile

Roofing tile, being fragile, must be handled with care. When loading tile on a truck, the roofer should stack the tiles on end on a cushioned surface, such as corrugated cardboard, blankets, and the like. (See Unit B, Topic 2, Roofing, Part 1.) This precaution is taken to avoid cracking and chipping the tile ends during transport.

When laying tile out prior to installation, the roofer should determine installation sequence so that the correct number of the right tiles can be placed in the most convenient locations. Such a procedure will eliminate much double handling, thereby reducing not only the time factor but the chance of tile damage. The smaller the number of tiles handled, the less are the chances for damage.

Regardless of the layout, however, certain precautions should always be observed. For example, tiles must be loaded on a roof in such a manner that they will not slip, fall, or otherwise endanger the roof structure or persons below.

Ground Stacking of Tile

Tile should be stacked on the ground in the following manner (Fig. C-2):

- The first row: stack a pile of tile flat to a height equal to the length of a tile ("A" in Fig. C-2). Stack tile on ends, leaning against the flat stack ("B" in Fig. C-2).
- The second row: add to pile "B" sufficient tile to bring the height equal to a second tier of tile ("C" in Fig. C-2). These tiles will rest partially on the first flat stack and partially on the pile of standing tile.
- The third row: proceed with this row in the same manner as the second.

It is not advisable to stack tile higher than four tiers because their own weight may cause chipping and breakage of the lower pieces.

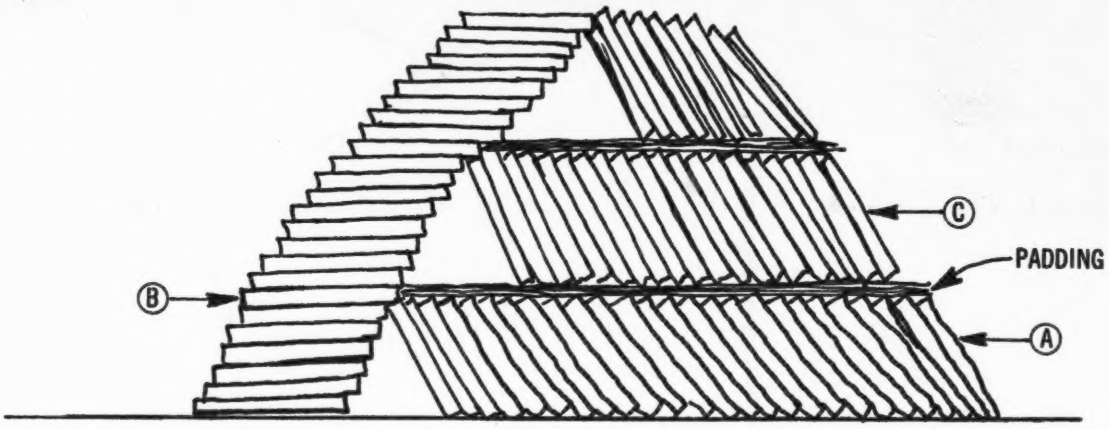


Fig. C-2. Ground stacking of tile

Lifting and Stacking Tile

On jobs where lift-bed trucks or conveyers cannot be used for loading, tile may be pulled up to the roof with an "A" frame pulley wheel and rope. Tile bundles should consist of 10 to 15 pieces. The rope should be wrapped around the pile at its center of balance, as shown in Fig. C-3. A lift-bed truck is a great time and energy saver and should be used if the terrain around the building will permit. As a safety precaution, the earth around the building should first be checked for firmness before rolling a truck in for loading purposes.

The roof underlayment should be sprinkled with dry cement before loading the tile on the roof. This prevents the tile, tools, and workmen's feet from sticking to the asphalt surface. If a sheet of underlayment (either sand-covered or mica-covered) is used, however, this procedure is unnecessary.

Depending on the pitch of the roof, a few tiles may be laid in a row, with the remaining tiles placed with their lower ends on these first tiles (Fig. C-4). In this way, the tile stack will be more level and less apt to slip off. Tile stacks should be evenly distributed piles over the roof area with no single stack more than 10-15 tiles high.

Stacks of tile should never be placed too near the eaves of a roof because of the danger of them slipping off, and also because of the inherent weakness of any roof overhang.

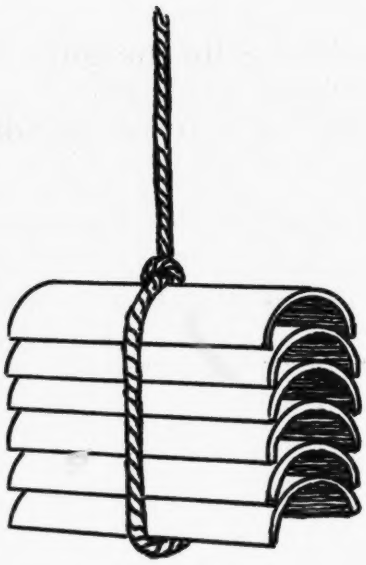


Fig. C-3. Lifting tile bundle with rope

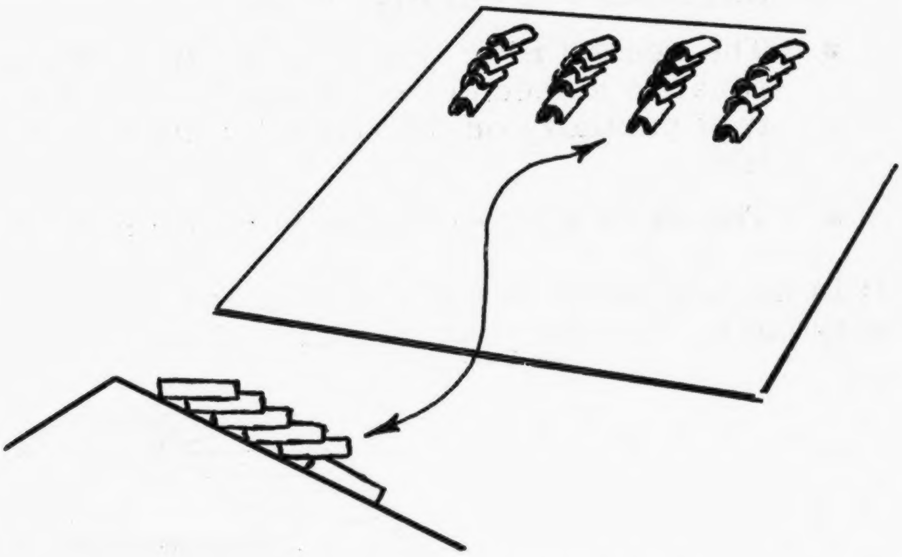


Fig. C-4. Stacking tile on roof

UNIT C--RIGID ROOFING

TOPIC 1--TILE TYPES, STACKING, AND LOADING

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. There are two basic types of tile. 1. T F

2. Spanish tile and French tile are similar in appearance. 2. T F

3. Spanish tile weighs 1,200 lbs. per square. 3. T F

4. Standard colors for shingle tile are gray, green, brown, and black. 4. T F

5. Tiles deteriorate more from imperfections than from age alone. 5. T F

6. Mission tile is made from clay and laid out in the sun to dry. 6. T F

7. Tile is generally glazed, which makes it waterproof. 7. T F

8. Tile thickness runs from 1/2 in. to 1-1/2 in. 8. T F

9. Some types of tile may absorb water up to 100 percent of their own weight. 9. T F

10. It is safe to stand a ladder on some types of tile. 10. T F

11. The maximum safe height for stacking tile is ten deep. 11. T F

12. Most tile is waterproof. 12. T F

13. Tile is the best roof covering to use in extremely cold areas. 13. T F

14. A "booster" helps greatly in the loading of a roof. 14. T F

15. Only a very light person can walk with an "eggshell step." 15. T F

UNIT C--RIGID ROOFING

TOPIC 2--TILE APPLICATION

This topic, "Tile Application," is planned to help you find answers to the following questions:

- Why is tile layout so important to an installation, and how should it be done?
- What problems do irregular roof shapes present to the roofer on a tile job, and how does he solve them?
- What are the accepted procedures to follow in loading a roof with tile?
- In what major way does mission tile vary from Spanish tile in respect to the finished job?
- What special precautions must be taken with tile roofs to avoid the possibility of leaks?
- What are the recommended steps to follow on a tearoff and recover job?

Knowledge of and skills in all phases of roofing are essential to the success of the apprentice. Because of this, the apprentice should grasp every opportunity to work on as many different kinds of roofing jobs as possible. Among these, tile work offers several challenging variations.

Each tile job presents its own layout, application, and flashing problems; therefore, this topic can offer only general suggestions for solving these problems. The information contained in this topic can be used to advantage if applied to these problems and adapted, if necessary, to fit the individual job.

Not all roofs will accept tile because of its weight. Only those structures constructed or reinforced to withstand the weight of this material should be covered with tile. Structures of this type usually have rafters made of 2 x 6s, or larger, and are often provided with additional support trusses or purlin. The rafters should be on 16-in. centers, and wall bracing must be more substantial than normally found in other structures. Frequently, walls are completely sheathed for additional strength. If a roof to receive tile is sheathed with plywood, the sheathing should be blocked at all joints.

The application of any roof is governed by local building codes. Therefore, before laying any tile roof, the roofer should determine that the specifications from which he will work conform to whatever building code is applicable in his area.

Preliminary Preparation for Roofing

Prior to the roofers arriving on a job to tile a roof, someone should have inspected the site to make sure the roof is ready for roofing and that the area around the structure is clear for access to trucks and other equipment.

As preliminary steps to tile application, the roofer should perform the following functions:

- Check the blueprints and specifications, work order, shop drawings, and change orders if any.
- Make a final inspection and a determination on tile layout.
- Sprinkle dry cement over the raw asphalt on the roof.
- Lay out the tiles as they are loaded onto the roof for the greatest convenience and advantage to those who will be laying the tile. Proper layout cannot be done conveniently after the tile is once loaded onto the roof.
- Separate and organize all "special" tiles, locating these pieces close to the area in which they will be used.
- Set diamond saw in a place most convenient for use.
- Apply tile ties if required.

Layout Methods

A layout is usually made for the installation of interlocking tile because not much opportunity for "give and take" is afforded by this type of tile. On simple roofs where interlocking tile is not to be used, however, experienced layers will make only a minimum layout or none at all. This is not recommended practice for the apprentice, however, and it should be remembered that unless a particular roof style calls for irregular lines, straight lines must be maintained for all tile courses and rows. (A "row" of tile runs from the eave to the highest part of the roof--usually the ridge; a "course" of tile runs horizontally, parallel to the ridge and perpendicular to the rows.)

The layout of vertical and horizontal guidelines may be made in the following manner: On a gable roof, vertical and horizontal guidelines may be laid parallel to the rake and ridge (respectively) of the roof. However, on a hip roof, or on any roof where the rakes or barge boards are not parallel to each other (nor perpendicular to the ridge or eave), the vertical guidelines must be established at a 90-degree angle to the horizontal lines. This can be done as illustrated in Fig. C-5.

- Scribe two arcs from points X and Y, which are equidistant from point Z. Scribing may be done by using a strip of wood not less than 10 ft. long as a trammel. Precaution: Never use a chalkline to scribe arcs because it stretches.

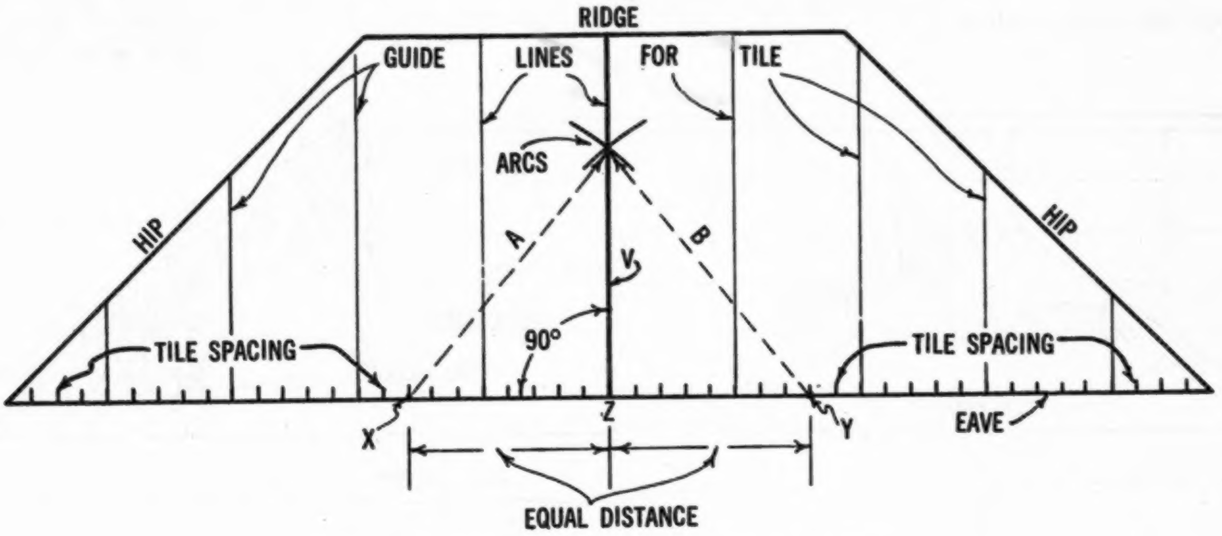


Fig. C-5. Layout of guidelines on a hip roof

- Strike a chalk line from point Z to the intersection of the arcs. This will form a vertical line (V) exactly perpendicular to the eave.
- Strike similar vertical guidelines on each side of the center line, making sure they are all parallel. As many lines as desired may be made, perhaps one for every five or six rows of tile.
- Horizontal lines may be struck as course guidelines, the number again depending on individual desires--some roofers use only a few lines; others may snap a line for every third or fourth course.

Spacing the Rows

Another layout method is to lay one full row and one full course of tile on the roof to determine how they may best be placed. Once this is established, marks are then made on the roof to indicate tile positions, and guidelines then struck in the manner previously described. In small or irregularly-shaped areas, it is sometimes necessary to lay all the tile in a loose fashion to determine final layout.

Because a hip roof with a valley is the most difficult to load correctly, this type of roof will be used in the following example of special considerations to observe when loading (Fig. C-6):

- Mark eave course line as shown in Fig. C-5.
- Snap remaining horizontal and vertical guidelines.
- Begin loading tile. (Title should be loaded above the fourth course level, allowing sufficient work room for installation of initial courses.)
- Using barrel tile, place eight pan tile and eight cover tile in alternate stacks above the fourth course. (This number may vary slightly, depending upon conditions.)

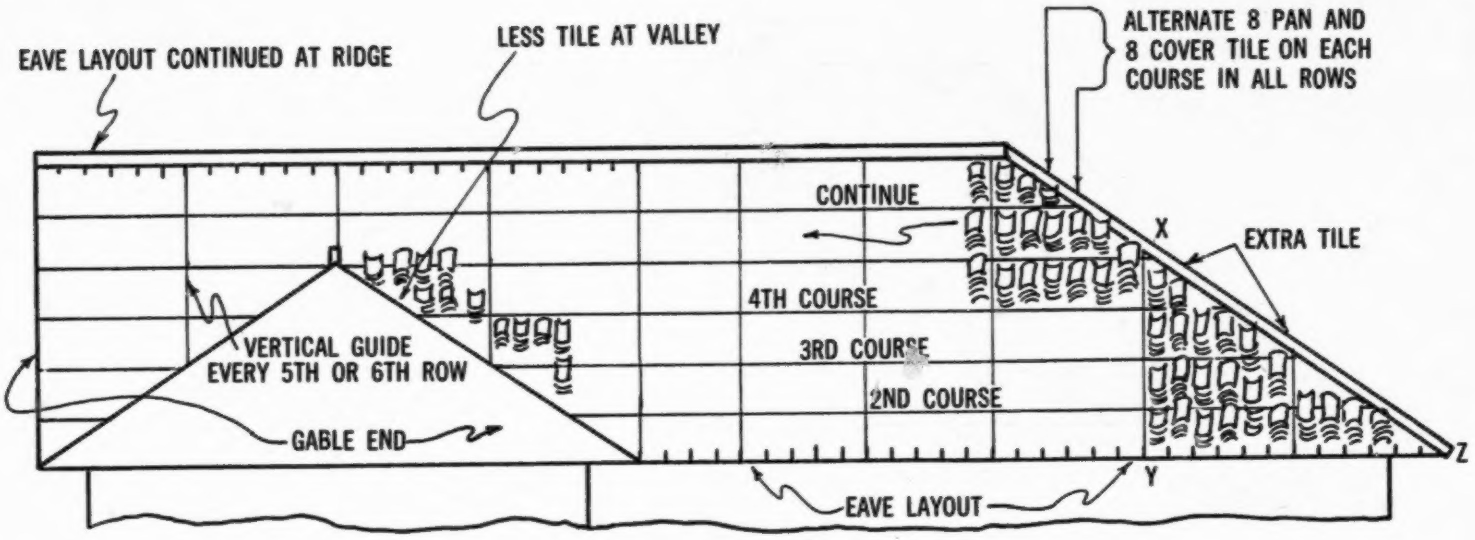

EAVE LAYOUT CONTINUED AT RIDGE
LESS TILE AT VALLEY
ALTERNATE 8 PAN AND 8 COVER TILE ON EACH COURSE IN ALL ROWS
CONTINUE
X
EXTRA TILE
4TH COURSE
VERTICAL GUIDE EVERY 5TH OR 6TH ROW
3RD COURSE
2ND COURSE
GABLE END
Z
Y
EAVE LAYOUT

Fig. C-6. Loading tile on a hip roof with a valley

- Since inadequate space is available to load tile for the point of the hip, load this triangular portion (X, Y, Z in Fig. C-6) from the eave to the point at which the fourth course will meet the hip line (X).
- You may load rake tile, like ridge and hip tile, along with the pan and cover tile, but pay special attention to this operation to see that "right-hand rake" and "left-hand rake" are loaded in their proper areas.
- Load a lesser amount of tile in the valleys. The number of tiles placed in each row should decrease in proportion to the row's length from the valley to the ridge.
- When you stack tile on a steep roof (6" in 12" for example), place one tile under the low end of the stack to prevent the stack from spilling.
- Do not concentrate too much weight on small areas when eave overhangs are exceptionally long.
- Always leave a sufficiently large area open for a small mud box, which serves as a central supply of mortar. This box should always be placed near the completion area of a roof.

Layout of Ridges and Hips

Ridges having one open end are laid as shown in Fig. C-7. Ridges having two open ends are laid as shown in Fig. C-8. (In the latter case, the tiles are laid beginning at each end of the ridge and capped by a single tile at the center.)

Spacing on hips and ridges may be adjusted, but an adequate lap must always be maintained when installing barrel tile. Spacing of interlocking shingle tile is governed by the interlocking grooves or the hanging strips, if any are used.

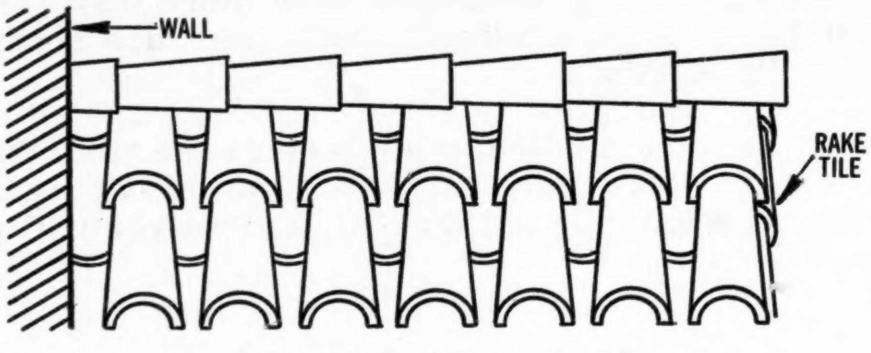


Fig. C-7. Ridge with one open end

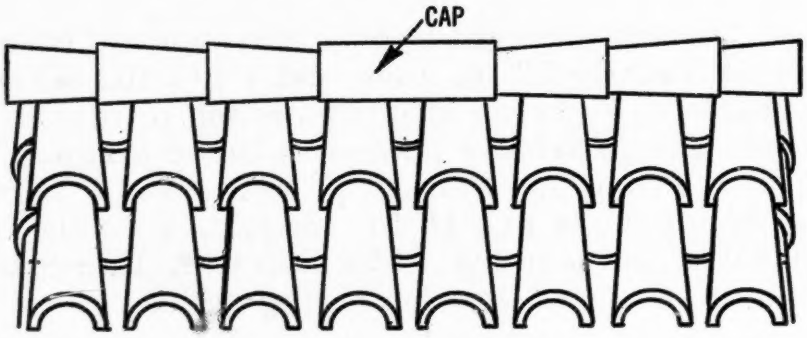


Fig. C-8. Ridge with two open ends

Spanish Tile

Spanish tile generally comes in two sizes, approximately 8 1/2 in. by 10 1/2 in., and 10 1/2 in. by 14 in. Such tile will vary in weight from 8 to 9 lbs. per sq. ft. The roofer should always measure the tile delivered to the job to determine if it varies even slightly from the size designated in the specifications. This is especially important with Spanish tile because the symmetry of the finished roof may be spoiled by any variation in tile size or layout. Also, if the channels for directing water off the roof are not in proper alignment (which may occur if tile sizes vary), the course of water may be obstructed or diverted in such a manner as to cause it to flow back under the tile.

Once the roofer has checked the size of the tile, he should then study the details to determine how much overhang the eave tiles will have. With this information at hand, he is able to measure and mark on the roof where the upper end of the first course will fall. From this initial mark the roofer is then able to measure for and mark succeeding horizontal lines for each of the courses to follow. Overlapping courses may be allowed for as necessary to avoid cutting tiles, but the lines must be kept parallel to the eaves and to the ridge nailing strips.

Once these horizontal lines have been made, the roofer may then determine the vertical spacing of tile rows (making necessary allowances for the rake tiles at the ends of each course). Dividers may be used to step these distances off. The dividers should be set to the width of each tile, measured from the edge of the pan side to just inside the side lap on the channel side. (This is done because each pan should overlap the side lap on the adjacent tile.)

The spacing from row to row should not vary more than 1/16 in. Once the vertical spacing has been determined, chalk lines are snapped at these points at right angles to the eaves.

When Spanish tile is to be applied to a hip roof, the tiles that intersect the hip line must be cut at the desired angle and laid flush and tight to the nailing strip. Likewise, tile must be cut and fitted to all vertical projections, such as chimneys and dormers.

Mission Tile

Mission tile is made in both straight barrel and tapered barrel shapes. The straight barrel type is usually 18 in. long and 7 1/2 in. wide. As with any tile, the size of mission tile varies slightly among different manufacturers, but the tapered barrel tile generally comes in three sizes: "small" (5 in. at one end, 6 1/2 in. at the other), "standard" (6 in. and 7 1/2 in.), and "large" (8 in. and 10 in.). All of these are 18 in. long. As a rule, mission tile weighs from 1,000 to 1,400 lbs. per square. Mission tile, like Spanish tile, requires an undertile in conformance with local building codes.

Since part of the appeal of mission tile is its appearance of having been handmade as were the original mission tile, symmetry is not as important in the finished roof as it is with Spanish tile.

Before the roofer begins to lay mission tile, he should measure the individual pieces to determine if they deviate from specifications. Sometimes the specifications call for pans and tops of slightly different sizes--quite often the case when tapered barrel tile is used--and the specifications should be checked closely on this point. In addition, the specifications may call for a variation in exposure for the cover tiles, one designed to ensure that vertical rows will be in alignment but the horizontal courses will not. This irregularity adds beauty and versatility to a mission roof. Some specifications call for the use of a combination of colors as a further means of adding to the irregular appearance of a roof.

The layout. In laying out a mission tile roof, first importance should be given to the location of the centerline of the pans. Centerline positions are usually stated in the specifications and should be followed closely as they determine the overall weight of the roof. Generally speaking, if large pans are used, the centerlines are 12 in. apart; if standard pans are used, the centerlines are 10 1/2 in. apart; and small tiles will require centerlines 9 1/2 in. apart. Most tile is stamped with a code, such as: "10-1/2 x 14," which means use 10-1/2-in. centers for the pans and 14-in. exposures for the tops.

If the roofer finds in laying out the first course that he cannot maintain the specified centerlines and still end his course with a full tile at each end, he may vary these centers slightly to avoid cutting any tile. On short spans especially, the roofer should make certain any spacing variations are kept as even as possible for the sake of appearance. Once these centers have been determined, the first horizontal course may be laid out parallel with the eave. Allowing 2 in. for overhang, he marks a point 16 in. up from the eave and snaps a horizontal line. This is done whether the roofer intends to lay the tile in symmetrical or random pattern. From this point on if the pattern is to be symmetrical, the roofer will snap additional horizontal lines parallel with the first line and 14 in. apart (or other distance, depending on the specified overlap), up to the ridge or other high point of the roof.

As was the case in horizontal layout, the roofer may find that he must vary his exposure in his vertical rows to avoid cutting tiles at the top. In this case, the exposure should always be reduced rather than lengthened because protection of the roof is the prime factor. When a symmetrical pattern is to be laid, the same variation in exposure should be maintained from tile to tile insofar as possible.

The eave course is the first to be laid,and the roofer generally works up the roof along the vertical rows. The channels created by the pans must be kept continuous and unobstructed, although not necessarily in a straight line.

Mission tile is fastened with nails or tile-tie systems as governed by local building codes. If nails are used, they must be inserted in each tile--both pans and covers--and must provide 3/4-in. penetration into the roof deck.

Leaks in Tile Roofs

New Roofs

A tile roof is not waterproof in itself because wind can always blow water in under the tiles no matter how well they are installed. Consequently, certain steps must be taken and other conditions avoided to ensure a good watertight job on a tile roof:

- An underlayment of top-mopped felt (2 layers of 30-lb. felt with 25-lb. asphalt between layers), or a mica- or sand-coat felt is needed under the tile.
- Any nails driven through the underlayment and into the deck should be sealed with fibrated plastic.

Old Roofs

A leaking tile roof can be caused by many things, but the most common causes are:

- Cracked, broken tile
- Shrinkage of flashing compound in reglets
- Incorrectly installed flashing
- Leaves and debris building up on the roof, damming up gutters or pan tile channels, causing water to back up
- Severely deteriorated underlayment

Tearoff and Recover

When an underlayment has deteriorated or the holes at anchor nails enlarged, it is necessary to remove the tile and apply a new underlayment. Because of the high cost of tearoff and recover procedure, underlayment should always be of the highest quality.

The steps to take on a tearoff and recover tile job are as follows:

- Remove the tile, starting at the eaves. Some of the tile will have to be lowered to the ground so that membrane may be applied a section at a time. If the entire roof must be recovered, it is usually more feasible to lower all the tile. (Note: The objective here is to handle the tile the least number of times, which saves labor and reduces the breakage factor.)
- When, due to circumstances, removal must begin at the top of the roof, clear a foot path first by removing two or three complete adjacent rows.
- Remove hip tile as field tile is removed.
- Pull straw nails and cut tie wires as removal progresses.
- Organize tile on the ground so it can be replaced on the roof in the same order as it was removed. (This is not important on a plain gable roof, except where tiles have been cut for vertical projections. On more complicated roofs, tiles should be marked with chalk for easy relocation. It is sometimes a good idea to make a simple layout drawing, showing special information or dimensions that will make relocating easier.)
- Keep a written record of all broken tile (type, size, color, and so forth), so that needed pieces can be ordered and delivered in time for the recover operation. Always keep tile protected from breakage when stored. (Rare tile, no longer produced, may be encountered from time to time. In these cases, extreme care must be taken to prevent damage.)
- Remove all flashings, nails, and undertile, and renail the deck where necessary. Perform any required deck repairs at this time. To save time, some flashings may be bent up out of the way and left in place.
- Apply undertile material in accordance with job specifications.
- Reinstall tile in the same manner as would be done with a new roof, installing flashing wherever needed.
- Clean up the job.

Safety Precautions

Tile is usually lowered from a roof by a derrick or ladder and wheel method. The roofer should see to it that such a device meets all standard safety requirements. (See Unit C, Topic 3, Roofing, Part 1.) In addition, the following precautions should be observed:

- Be careful of accumulated dust and dirt under the old tile. This dirt can make the roof extremely slick, especially when wet, and care should be taken when walking on the roof.
- Bees, hornets, and other insects will often nest underneath tile. Keep an insect spray can handy for this purpose, and do not reach under any area with the bare hand without first looking for such danger.
- Pull out or drive in all protruding nails when tile is removed. This will eliminate the possibility of injury being incurred by kneeling on or tripping over such projections.
- Lower broken tile and refuse to the ground in containers or chutes. Never throw anything off the roof.

Study Assignment

1. James McCawley, Roofing: Estimating-Applying-Repairing, pp. 221-30.
2. Manufacturers' Specifications.
3. Review: Roofing, Part 1, Unit B, Topic 2, p. 34; Unit B, Topic 3, p. 56; and Unit C, Topic 5, pp. 63-69.

UNIT C--RIGID ROOFING

TOPIC 2--TILE APPLICATION - Study Guide and Checkup

Study Guide

After you have studied the material in the workbook and the assigned material, complete the following exercises:

1. Illustrate by drawing cross-section sketches the differences between various tile types:

   Pan Tile

   Interlocking Tile (Spanish)

   Plain Spanish Tile

   Mission Tile

   Plain Shingle Tile

2. Why does layout differ for various roof tiles?

3. Give three reasons why proper layout is important:

4. Describe the steps in laying out a gable roof for tile:

5. What is the major difference in layout for Spanish and mission tile?

6. Why is correct layout more important for interlocking tile than for pan tile?

7. Why should a roofer not lay tile on a roof which has been previously wood shingled?

8. What is the difference in the construction between a roof designed for tile and one designed for wood shingles?

9. If plywood sheathing is used under a tile roof, what in particular should the roofer check for prior to laying the tile?

10. What is the difference between plumbing extending through a tile roof as compared to the same thing on a shingle roof?

11. Why should tile have specified breaking strength?

12. Why should tile have limited water absorption characteristics?

13. What are the dimensions of the two sizes of Spanish tile?

14. Spanish tile varies how much in weight per square?

15. What are the two names for the felts mopped on before the tile is laid?

16. Under what conditions does 15-lb. felt always have to be mopped?

17. Why will the same type of tile vary in size, and how does this affect the installation?

18. What is the difference in the right and left rake of Spanish tile?

19. What is the purpose of the pan or channel in tile?

20. What is a booster tile?

21. What are the seven special tools used by the roofer on tile work?

22. How does a roofer strike a right-angle layout on a roof?

23. Where are tile tying systems required?

24. What different methods are used to tie or fasten tile to the roof?

25. Why should protruding nails be driven or pulled when tile is removed?

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. Galvanized metal and copper can be used together in some climates. 1. T F

2. A symmetrical roof is one in which the sides are straight and run parallel or perpendicular to each other. 2. T F

3. Incorrectly installed flashings are a major cause of leaks on tile roofs. 3. T F

4. A row of tile runs horizontally, while a single course runs vertically. 4. T F

5. A mud box is used to collect dirt and dust that collects under a tile roof. 5. T F

6. Mission tile is usually installed in a symmetrical manner. 6. T F

7. Tile underlayment need not be nailed because the tile is waterproof. 7. T F

8. On the ordinary residence with a tile roof, support rafters are usually 2 x 6s, spaced 16 in. on center. 8. T F

9. Plywood sheathing is not recommended for roof decks designed for tile application. 9. T F

10. Barge boards and rake edge boards are the same. 10. T F

11. Dimensions for tapered tile vary among manufacturers. 11. T F

12. Measuring standard tiles prior to installation is not necessary on most jobs. 12. T F

13. "Straw nails" is a term given to the first type of nail used in tile work, but no longer used. 13. T F

14. Underlayment actually waterproofs a roof, rather than the tile itself. 14. T F

15. In consideration of the normal life span of tile, only lead or copper flashings should be used. 15. T F

UNIT C--RIGID ROOFING

TOPIC 3--TILE TIES AND TYING METHODS

This topic, "Tile Ties and Tying Methods," is planned to help you find answers to the following questions:

- What are the chief materials used to fasten tiles?
- What part do nails play in the installation of a tile roof?
- When are field strips used and for what purpose?
- What two major kinds of wiring methods are generally used in tile work?
- When is mortar used on tile roofs, and in what areas will it generally be needed?

Fastening Methods

Wooden pegs and rawhide ties were used many years ago for fastening tile to roofs. Today in the United States, however, different and more convenient methods are employed for this purpose. Although the weight of the tile itself will usually hold it in place on a flat roof, public safety and protection of property have resulted in building codes requiring the fastening of tiles. If the tiles are not tied, it is possible for wind to blow them off.

Typical methods used to fasten tiles to a roof and the materials used for this purpose are described in this topic. Other patented methods or materials may be encountered by the roofer, but familiarity with the basic principles will make it possible for a roofer to adapt to any existing system.

The major tile fastening materials used today are nails, wire, metal strips, cement, and combinations of these.

Nails

Tiles may be nailed directly to the roof deck. A major disadvantage to this method is that it results in many holes in the deck that may leak later on when they start to enlarge through expansion and contraction of the under-tile. This condition may be at least partially prevented by the application of self-healing plastic around each nail.

Long straw nails (up to 6 in.) may be used on cover tiles when pan tiles are installed, with a shorter nail used for the pans or channels. Shingle tiles also require a shorter nail.

In some cases 1 x 2 or 1 x 4 field strips are nailed directly over the underlayment, and the cover tile is nailed to them. This method provides added support, better alignment, and easier nailing with no need for tie wires. Such nailing strips (although larger--usually 2 x 4, 6, or 8) are often used for nailing ridge and hip tiles, depending on the style of installation being followed. The nails used to secure tiles are usually aluminum, copper, or galvanized wire.

Driving and sealing nails. Nails used to anchor tile must be driven in just far enough to anchor the tile snugly, but not so far as to break the tile. If the nails are not snug, the tile will rattle on windy days. Nail heads and the points at which the nail will penetrate the deck should, whenever possible, be treated with a self-healing material.

Wire

Tie wire is used to secure both pan tile and shingle tile. Sometimes the wire is threaded through the holes in the cover tile and fastened to nails driven into the deck above each tile piece (Fig. C-9).

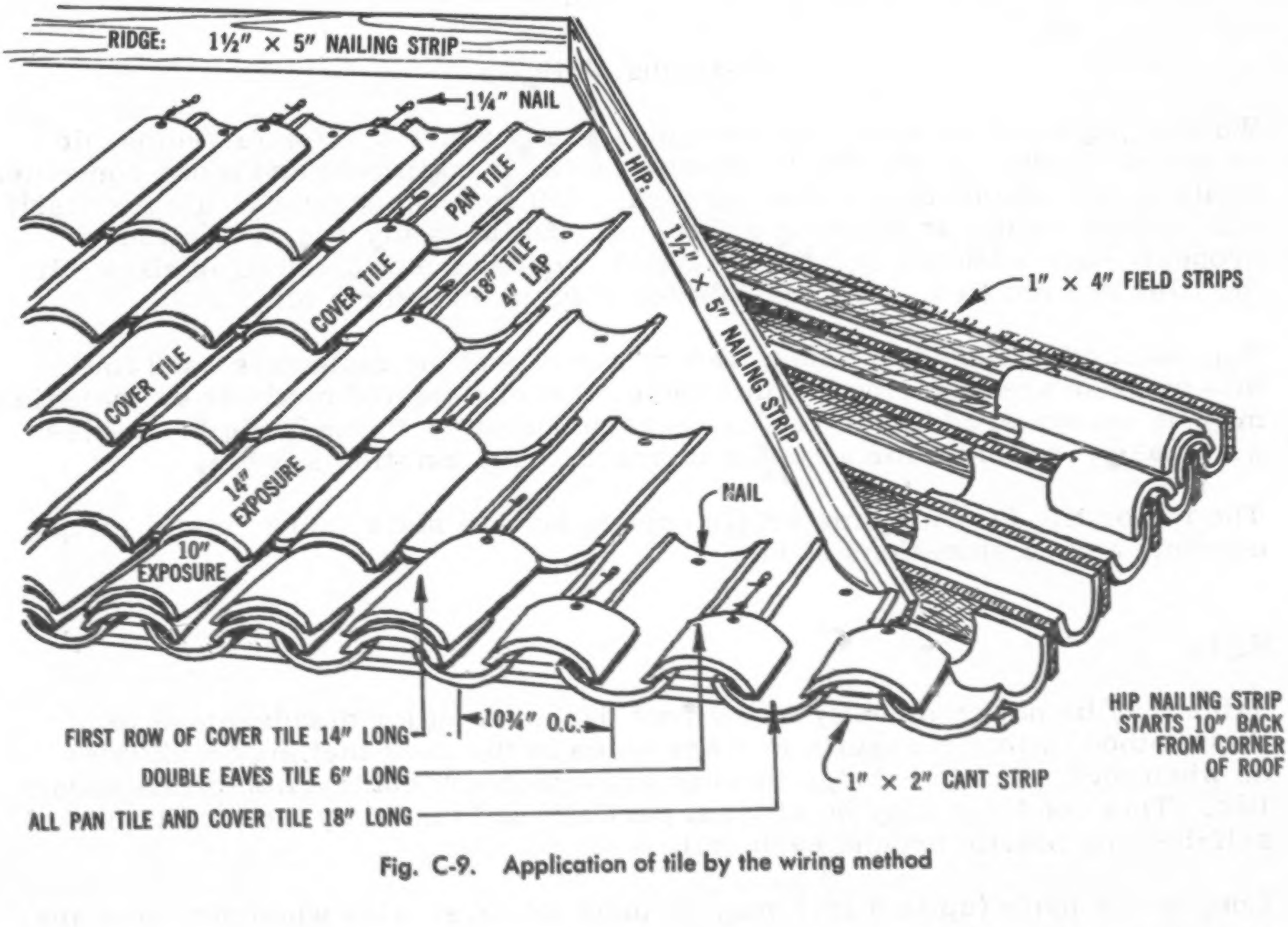

RIDGE: 1½" × 5" NAILING STRIP
1¼" NAIL
PAN TILE
HIP: 1½" × 5" NAILING STRIP
1" × 4" FIELD STRIPS
18" TILE 4" LAP
COVER TILE
COVER TILE
14" EXPOSURE
10" EXPOSURE
NAIL
FIRST ROW OF COVER TILE 14" LONG
10¾" O.C.
DOUBLE EAVES TILE 6" LONG
ALL PAN TILE AND COVER TILE 18" LONG
1" × 2" CANT STRIP
HIP NAILING STRIP STARTS 10" BACK FROM CORNER OF ROOF

Fig. C-9. Application of tile by the wiring method

The application of tile by the wiring method is illustrated in Fig. C-9. The roof sheathing is covered with felt, and each pan tile is nailed to the sheathing with one copper nail. Each cover tile is then wired, and the wire is nailed to the sheathing. This method is the most popular for attaching tile to a roof because of the speed, economy, and slight irregularity of the vertical alignment that is possible.

Another method consists of fastening to the deck a long, twisted, double strand of tile tie into which is lashed the ties from individual tiles (Fig. C-10). This is the method commonly used on concrete decks, mainly because it requires a minimum number of nails.

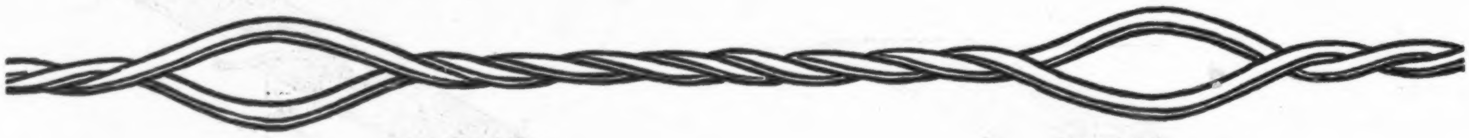


Fig. C-10. A typical tile tie

Although galvanized wire is sometimes used for this purpose, it is not recommended because the wire rusts rapidly, especially in those geographic areas where ocean air is present; a copper-alloy wire has proved to be the most practical in these cases. The gauge of the wire used depends upon the slope of the tile, since the weight the tie must carry increases proportionately with the pitch of the roof. (Refer to the manufacturer's tile-tie charts to verify that the correct material has been specified.)

Tie strips. Tie strips are used when the strength required for the job is greater than that afforded by wire (Fig. C-11). These strips, applied to either concrete or wood decks, will serve the same purposes as twisted wire ties.

The tile "hook and loop" tie is another method of tying that requires a minimum of nailing. The principle used in fastening mission tile applies equally to shingle tile.

Cement

Another method of setting tiles involves the use of mortar. This method is sometimes used for special architectural effects or when roofs are subject to high winds or excessive foot traffic. The chief disadvantage of the use of mortar is that it does not allow for the normal expansion and contraction of a roof, and this often leads to cracking.

Cement mortar is applied by "buttering" each piece and then setting it in place. The mixture used consists of three parts of fine washed sand to one part Portland cement, with just enough water added to make it easily workable. The mortar is sometimes colored with oxides to match the tile.

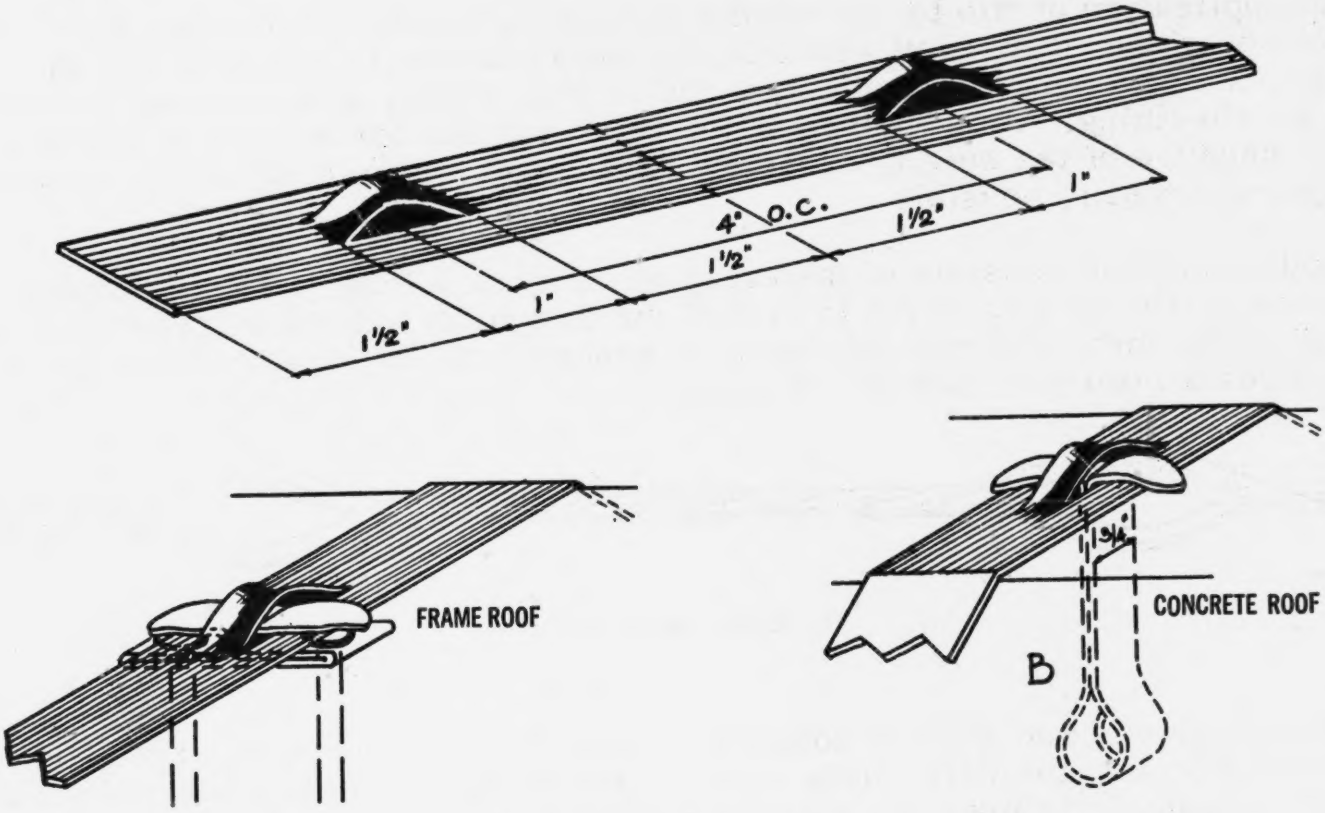


Fig. C-11. Typical tie strips

Tile that is to be cemented in this manner should be dampened to prevent too-rapid drying. Flat tile, pan tile, or coping tile are often applied with mortar, although in some cases asphalt or mastic is used instead.

Hanging or Furring Strips

Furring strips may be used to fasten pan tile, although its one main disadvantage is that a great many holes occur in the deck from the nailing. If furring strips are used, the lumber should be such as to resist dry rot (Fig. C-12).

Fastening Mission Tile

Either the tile tie system or nailing is used to fasten mission tile. The tile tie system used consists of two parts--tile tie strips (lengths of standard wire or brass strips) fastened to the roof deck and shorter tie wires that connect the tiles to these strips.

The tile tie strips are set at right angles to the eaves and run from the eaves to the ridge. They are fastened to the deck by specially made anchors. They may be placed in one of two ways: either under every vertical row or under every other row. These strips should be put in place before any tile is loaded onto the deck.

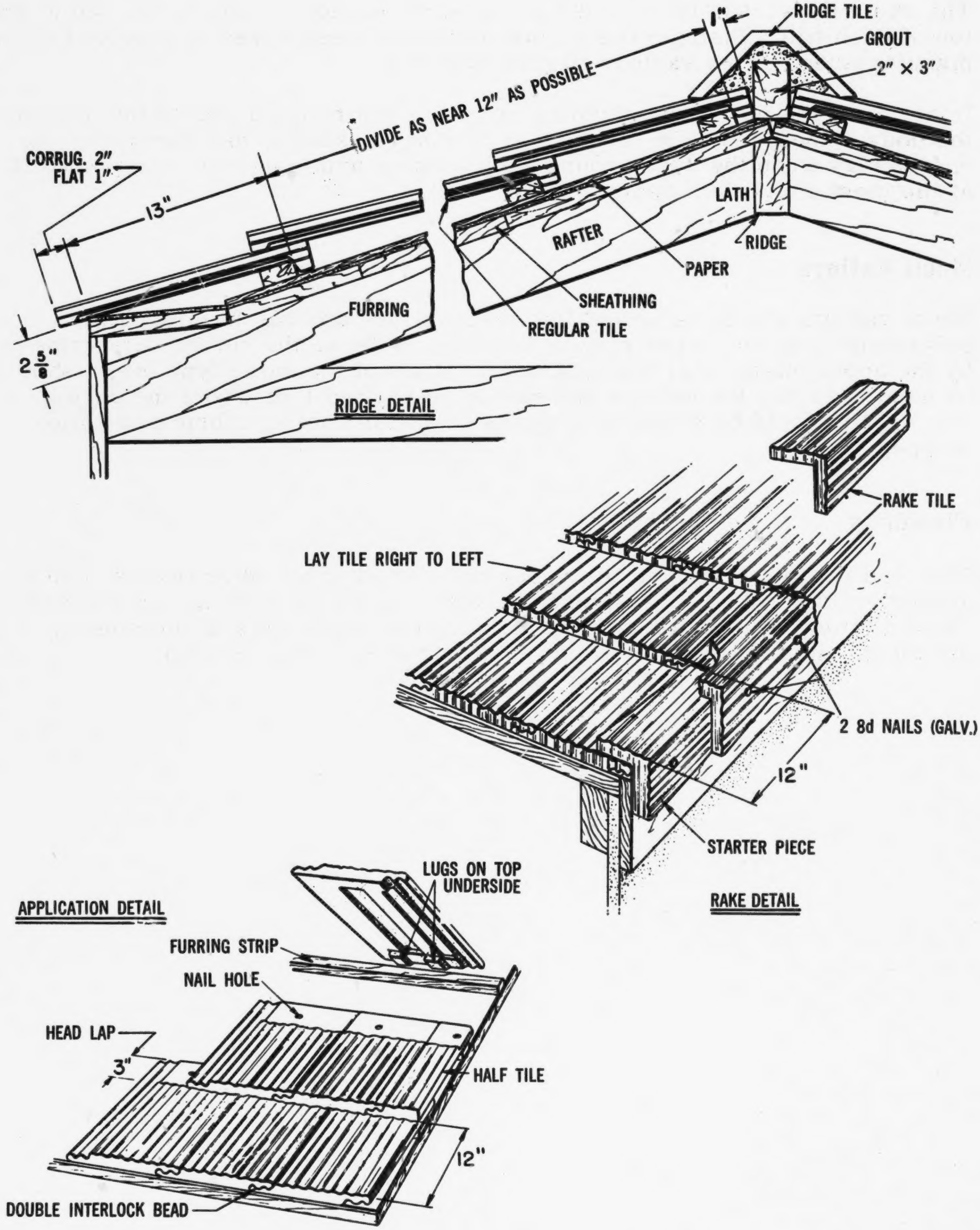

RIDGE TILE
GROUT
2″ × 3″
1″
DIVIDE AS NEAR 12″ AS POSSIBLE
CORRUG. 2″
FLAT 1″
13″
LATH
RAFTER
RIDGE
PAPER
SHEATHING
FURRING
REGULAR TILE
2 5/8″
RIDGE DETAIL
RAKE TILE
LAY TILE RIGHT TO LEFT
2 8d NAILS (GALV.)
12″
STARTER PIECE
RAKE DETAIL
APPLICATION DETAIL
LUGS ON TOP
UNDERSIDE
FURRING STRIP
NAIL HOLE
HEAD LAP
3″
HALF TILE
12″
DOUBLE INTERLOCK BEAD

Fig. C-12. Installation of shingle tile with furring strips

The short tie wires are fastened to the strip and to the hole in the pan at the top of each tile. Instructions on how to fasten these wires is provided by the manufacturers of the various tile tie systems.

In areas on the roof where holding strips cannot be anchored to the deck in the conventional manner--such as at chimneys, shafts, and dormers--the roofer may wrap the wire around such an item and fasten the tile ties to it at the most convenient spot.

Metal Valleys

Metal valleys should be nailed into place before any tile is laid. Either galvanized iron or copper may be used for valleys, the choice determined by the appropriate local building code. Nails of the same type metal should be used to fasten the valleys and should be applied 1 in. from the edges. The edges should be sealed with glass or cotton roofing fabric and solid-mopped.

Flashings

The lead flashings used on tile roofs are furnished by other trades, but are applied by the roofer. Flashings are installed as the roof is laid and are "woven" into the tiles where needed around pipes, dormers, chimneys, parapets, and the like. (See Unit A, Topic 4, and Fig. F-32.)

UNIT C--RIGID ROOFING

TOPIC 3--TILE TIES AND TYING METHODS

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The gauge of wire to use for tile ties is determined primarily by the steepness of the slope. 1. T F
2. Wooden pegs and rawhide are still used to fasten tiles in those areas where metal would corrode. 2. T F
3. Cant strips should be used when fastening mission tile. 3. T F
4. Aluminum, copper, or galvanized wire nails are used for securing tile on roofs. 4. T F
5. Tiles set in cement are more subject to cracking because of roof movement. 5. T F
6. Tile should be dampened before being cemented. 6. T F
7. A "tile tie" is an anchor for securing tile. 7. T F
8. Furring strips may be used as a means of fastening certain tiles in place. 8. T F
9. Cement, wire, metal strips, and nails are all used for securing tile. 9. T F
10. Tiles may be nailed directly into a roof deck. 10. T F
11. Undertile need not be sealed at entrance of nails. 11. T F
12. Tie wire may be used with both pan and shingle tile. 12. T F
13. An inherent disadvantage of furring strips is that the many nail holes become potential roof leaks. 13. T F
14. Tile tie strips run horizontally across the roof and are set every other course. 14. T F
15. Lead flashings are supplied and installed by the roofer. 15. T F

UNIT C--RIGID ROOFING

TOPIC 4--ASBESTOS CEMENT SHINGLES AND SLATE

This topic, "Asbestos Cement Shingles and Slate," is planned to help you find answers to the following questions:

- What are the sources and types of asbestos cement shingles and slate?
- What special tools are required for the installation of asbestos cement shingles?
- What type of fasteners are used on asbestos cement shingles?
- In what sizes and thicknesses is slate supplied for roofing purposes?
- Why are slater's tools essential to a good slate roof job?
- What special precautions must be taken when installing an asbestos cement or slate roof?

One of the most interesting things an apprentice roofer can do is learn the application of the more exotic roofing materials--slate, straw, and asbestos cement, to name a few. Even though the apprentice may not have an early opportunity to work with this type of material on the job (roof jobs calling for these materials are few and far between these days), he should still have acquired sufficient knowledge through his studies to work on such jobs with some skilled journeyman should the need arise.

This topic deals with two roofing materials that the apprentice might well be called upon to install--asbestos cement shingles and slate. Both of these products offer special installation problems to the roofer, and their unique characteristics are a challenge to the craftsman who must also deal with varying roof shapes and configurations.

Study Assignment

James McCawley, Roofing: Estimating-Applying-Repairing, pp. 177-96 and 203-21.

Topic for Discussion

Be prepared to discuss the following if you are asked to do so:

> "What are the four major types of asbestos cement shingles, and what are their outstanding features?"

UNIT C--RIGID ROOFING

TOPIC 4--ASBESTOS CEMENT SHINGLES AND SLATE

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. One of the advantages of the asbestos cement shingle is its high impact resistance. 1. T F
2. An underlayment is required under asbestos cement shingles because water will soak through them. 2. T F
3. Asbestos cement shingles should always be nailed hard to the roof deck. 3. T F
4. Layout and alignment of asbestos cement shingles is the same as for asphalt shingles. 4. T F
5. Another name for Dutch lap shingles is Scotch lap. 5. T F
6. Cant strips or starter strips are not required for use with asbestos cement shingles. 6. T F
7. A roofer should avoid walking on asbestos cement shingles. 7. T F
8. The minimum pitch of a roof to be covered with asbestos cement shingles is 3" in 12". 8. T F
9. Asbestos cement shingles should be installed only during dry weather. 9. T F
10. Furring strips are used to build up hips and ridges so that shingles will assume the proper level. 10. T F
11. The removal of asbestos cement shingles may best be done with a shingling hatchet. 11. T F
12. Slate that is 1-3/4 in. thick is used for most roof work. 12. T F

13. Slate is waterproof under all weather conditions. 13. T F

14. That part of a slate roof most vulnerable to damage is the fastener. 14. T F

15. One advantage to slate is that battens may be laid in any position. 15. T F

unit

d

Blueprint Reading

TOPIC 1--BLUEPRINTS AND THEIR USE

This topic, "Blueprints and Their Use," is planned to help you find answers to the following questions:

- What are blueprints, how are they made, and in what varied forms may one expect to find them?
- What is architectural language, and how is it used?
- What do architectural drawings usually consist of?
- In what way does a set of plans for a "Class A" structure differ from others?
- How does a roofer use blueprints, and how extensive should be his knowledge regarding such drawings?

The Blueprint as Related to Roofing

Many individuals and groups of persons work together to bring a new building to completion. The enormous amount of information needed by those concerned with the structure must be put into an organized, compact, and readable form. The architect first develops this information in the form of architectural drawings, plan views, elevations, sections, and details by using what might be called the "language of drafting." On very large or especially complicated structures, separate drawings are generally made for each trade, such as plumbing, electric wiring, air conditioning, and heating. This is not usually done for the roofing trade as this work is included on the "architecturals." In addition to all of this, the architect prepares written "specifications," which provide certain information about some items--information that could not be shown conveniently on a blueprint. These specifications accompany the blueprint. (The worksheet--sometimes called the "spec's" by the roofers--given to the roofing foreman by the contractor is an interpretation of the architect's specifications.)

Not too many years ago all architectural drawings were reproduced from tracings, and the resultant "prints" were blue with white lines (hence, "blueprints"). This term has remained in common use even though several new processes that do not produce the same type of print have been developed. Today it is common to find such prints in the form of ozalids (blue lines on white background--sometimes called simply blue-line drawings), Van Dykes (brown lines on a white background), and others that produce straight black-on-white-prints.

Blueprints gained initial popularity because of their permanence and because they were easy to read, even in bright sunlight. Their main disadvantage, however, has always been that they were difficult to mark or write on without special pencils or pens. The newer forms of printing are now widely used. Even so, all of the forms are still referred to equally as "blueprints," "prints," or just "drawings."

The Architectural Drawing

Architectural drawings consist of the following:

- Plans -- a view looking down on the subject
- Elevations -- side and face views
- Sections -- cut through to show construction
- Details -- precise detail for fabrication
- Shop drawings and change orders

All roofers should be familiar with all types of roofs and should be able to recognize them on house plans. They should also have a good general understanding of the entire set of drawings. A roofer should know the proper names for all parts of a roof structure so he can identify them on a print and use this knowledge in estimating. He should also know how to use the construction specifications and understand their relationship to the drawings. (Roofing construction specifications may be augmented by reference to manufacturers' specification manuals.)

Although the roofer is not concerned with the entire set of drawings on a structure, he should still have a knowledge of what the drawings cover. The reasons for this are as follows:

- The roofer may, in addition to installing roofs, be called upon to apply siding, foundation and wall waterproofing, floor membranes, and the like.
- The roofer should know the general layout of the buildings on the site before going to the job and should have sufficient information on the structures to inspect them prior to roof installation.
- The roofer will make fewer errors in planning the job.
- It will not be necessary for the roofer to ask someone else to read the drawings.
- The better the roofer's knowledge of blueprints, the better are his chances of success in his field.

Architectural Language

It would be virtually impossible to describe in words alone all the details of a building structure. A more efficient way of transmitting the architect's ideas to the builder is by architectural drawings in the form of blueprints. A complete set of drawings and specifications may be mailed to any location, and a building can be constructed from them without any verbal communication between the designer and the builder. Whether the blueprints and specifications are for a large office building, factory, or a simple residence, the same architectural "language" is used; hence, the apprentice roofer cannot begin too soon to gain a thorough mastery of that language.

Preparation of Blueprints

House plans are usually prepared by the architect and the owner (or builder) working together. It is the architect's job to interpret the desires of the owner into a design that meets the owner's mode of living and his budget. Since all items cannot be noted on the drawings, a set of specifications is prepared, itemizing in detail the catalog numbers of fixtures, appliances, and the like; the various concrete mixes, types of materials, and hardware; the areas of legal responsibility, type of workmanship, time limits, and so forth. (See Unit E, Topic 2.) Specifications are usually prepared in the form of a typewritten booklet.

Several sets of blueprints are generally made through a process similar to that of photography. More than one copy is always needed because many individuals or firms must have them in order to complete the structure. These copies are first made available to contractors and subcontractors for use in preparing bids and estimates. The owner will usually be given one copy; the local building department, the loan company, or bank will each be given one copy, and the general contractor will be given several. On large jobs the roofing contractor will frequently secure details of all items pertaining to his phase of the work, and job superintendents and major suppliers are often supplied with copies.

Drawings for large "Class A" structures differ from others only to the extent that considerably more details and specifications are involved, and engineering service provided. But the fundamentals to be gained by studying the architectural drawings of a house will prepare the apprentice to understand almost any drawing with which he may be confronted in the future.

Use of Blueprints

There are four main reasons why blueprints are prepared:

- To show how the finished building will look when completed: views of exteriors, plan, and elevations show the style, shape, arrangement of windows and doors, design of porches, entrances, chimneys, and the like.
- To show how the building is to be constructed: the blueprints will show the type of foundation to be used, how the different parts are to be fastened together, the construction of walls and roof, and the materials to be used for the structure.

- To indicate the size, shape, and location of all parts of the building: The blueprints are drawn to scale, and all of the main dimensions are written in. All measurements must be carefully checked and followed from the start of the job to the finish.
- To make it possible for contractors to prepare an estimate of the total cost of constructing the building, or for the carpenter, mason, plasterer, roofer, or other building tradesman to make lists of material to be delivered to the job.

The blueprints of a simple five-room house usually consist of not more than six sheets, with eight to twenty pages of specifications. If the house is especially complicated in design, a number of extra detail sheets will be attached. These sheets will include:

- The plot plan
- The foundation plan
- The floor plan
- Elevations (North, south, east, and west, as well as auxiliary views are usually included. Occasionally some construction details may be included on the elevations.)
- Interior wall elevations with cabinet details. (Occasionally, other construction details will be included on these.)
- Construction details that comply with particular code requirements for the area in which the structure is being built. (This may include, among other things, sections and elevations of parapets, windows, framing, fireplace and chimney, other special features, and nailing schedules.)

Each architect has his own means of expression and his own style. Consequently, variations will be found in symbols, conventions, schedules, and lines used on blueprints coming from different architects. However, these will not be so different that they cannot be understood and correctly interpreted by the apprentice who understands the fundamentals of blueprint reading and can, therefore, adapt himself to any architect's style.

Study Assignment

J. Ralph Dalzell, Building Trades Blueprint Reading - Part 1. Chicago: American Technical Society, 1956, pp. 5-6.

Study the blueprints in Building Trades Blueprint Reading Examination Kit, noting the many things included, especially the roofing waterproofing section.

Secure several sets of blueprints from your instructor or from a roofing contractor, and note the variations in organization.

UNIT D--BLUEPRINT READING

TOPIC 1--BLUEPRINTS AND THEIR USES

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) select the word that belongs in each numbered space in an exercise; and (2) write the word at the right in the space that has the same number as the space in the exercise.

1. Complete information about the roofing of a building may be obtained from the ____1____ and ____2____.

1. ____________
2. ____________

2. Specifications may sometimes refer the roofing contractor to the manufacturer's ____3____ on roofing products.

3. ____________

3. Building plans are initially developed through the cooperative efforts of the ____4____ and the ____5____.

4. ____________
5. ____________

4. In relation to the construction of a large "Class A" building, the roofing contractor is a ____6____.

6. ____________

5. Copies of specifications and plans are often needed by ____7____, ____8____, the ____9____, ____10____, ____11____, ____12____, and ____13____ and ____14____.

7. ____________
8. ____________
9. ____________
10. ____________
11. ____________
12. ____________
13. ____________
14. ____________

6. Blueprints are supplemented by ____15____ statements called ____16____.

15. ____________
16. ____________

7. The four views normally found in a set of house blueprints are ____17____, ____18____, ____19____, and ____20____.

17. ____________
18. ____________
19. ____________
20. ____________

8. A set of plans that consist of brown lines on white paper are really ____21____ ____22____ prints.

21. ____________
22. ____________

9. The two types of drawings which architects may make for a proposed house are ___23___ views and ___24___ drawings.

23. __________
24. __________

10. The most efficient way of expressing ideas about the design of a building is through the use of architectural ___25___.

25. __________

UNIT D--BLUEPRINT READING

TOPIC 2--ROOF SKETCHING

This topic, "Roof Sketching," is planned to help you find answers to the following questions:

- How can a roof sketch be made of an existing building?
- How can a roof sketch be made from elevations?
- What pertinent information for estimating purposes should be noted on a roof sketch?
- What safety rules and special precautions should be observed when sketching a roof on a job site?

Need for a Roof Sketch

Every roofer should know how to make an intelligible sketch of an existing roof with details, dimensions, and pertinent information for reroofing purposes. The apprentice who learns to do this will not only broaden his knowledge of the trade but increase his value to any employer. Some basic training in architectural drawing is a valuable asset to any roofer, for he can assist his employer in securing new jobs by providing accurate information concerning the roofs he works on.

An apprentice sent out on a repair job may find that no repairs can be made due to advanced deterioration of the roof. Instead of returning to the shop with a report that nothing could be done, the prepared apprentice will take the time to measure and sketch the roof, noting certain details such as flashings, projections, and overall dimensions. In this way he will provide his employer with a potential sale and, perhaps, additional employment for himself.

Estimate Forms

As a courtesy to contractors, roofing material manufacturers supply roofing estimate forms on which is printed a crosshatched section for sketching a roof to scale. Generally, a 1/4-in. or 1/8-in. crosshatch is used for this purpose, and any size of roof may be sketched on these forms, providing the appropriate scale is chosen. Estimate forms also include a material, labor, and overhead checklist. (Many contractors print their own forms with certain modifications to fit their particular operation.)

A typical checklist of items found on an estimate form should include the following:

Pitch of roof and its parts
Gutters
Air conditioners and ducts
Roof protrusions
Chimneys
Dormers and skylights
Expansion joints
Sections or parts requiring special flashing
Guy wires
Access areas
Signs and signposts
Work areas
Antennas
Porches
Decks
Drains and leaders

The following notations should be included on roof sketches from which an estimate is to be made:

Address and general location
North symbol
Need for protection of plants, property, and material
Unsupported rafters
Outside wall heights
Access to roof
Special flashings required
Type of wall construction (covered, coated, or treated)
Type of deck involved
Type of existing roof
Devices mounted on roof
Replacements needed
Washbacks, saddles, and the like (showing hidden lines if necessary)
Direction of drainage
Fire protection
Safety precautions
Trash removal problems
Desires of owner or tenant
Whether all areas can be figured into costs
Special problems

Safety Rules and Special Precautions

Whenever climbing upon, measuring, or sketching a roof, observe the following safety rules and take whatever other precautions common sense demands:

- Make measurements from the ground whenever possible.
- Be sure the ladder is sound. Do not use owner's ladder unless it is of good quality and in sound condition.
- Climb on roofs only if the slope is flat enough to be safe. (A pitch of over 8" in 12" is considered too steep under most conditions. The steepness must also be considered in relation to the roof's condition: composition roofs usually provide good traction; old, dirty, or damp wood shingles are generally slippery.)
- Keep away from electric wires. Never touch them. Be careful to keep away from all low-hanging wires that may carry electricity.
- Take no unnecessary chances by climbing to hard-to-reach places. It is sometimes better to estimate an inaccessible area than to try to reach it.

- Exercise extreme care not to cause more damage to an already deteriorated roof.
- Take normal precautions to protect plants and shrubs around the building.

Making the Sketch

A roofer should be able to make a roof plan sketch from elevations or from a perspective drawing. In this regard, the following points should be kept in mind:

- A "bird's eye perspective view" simulates that which would be viewed by the roofer if he climbed onto the roof.
- Elevations simulate a view of the house from the ground.
- Elevation views are generally drawn to a scale of 1/4 in. = 1 ft. or 1/8 in. = 1 ft., but the elevations included in this topic are, for space considerations, made to a scale of 1/16 in. = 1 ft. This is the scale that must be used to prepare a roof sketch from the elevations.

A roof sketch may be made by measuring the elevations directly from the ground, although a flat roof with parapets would have to be measured and sketched from the roof itself.

There are four ways to determine the pitch of a roof:

- Using a pitch card
- Using a spirit level and a rule
- Sighting over a folding rule, adjusting it until the two sections match the roof slope, then measuring the rise per foot
- When calculating from a blueprint, extending the eave and roof lines and measuring the rise per foot or checking for the symbol indicating the roof pitch

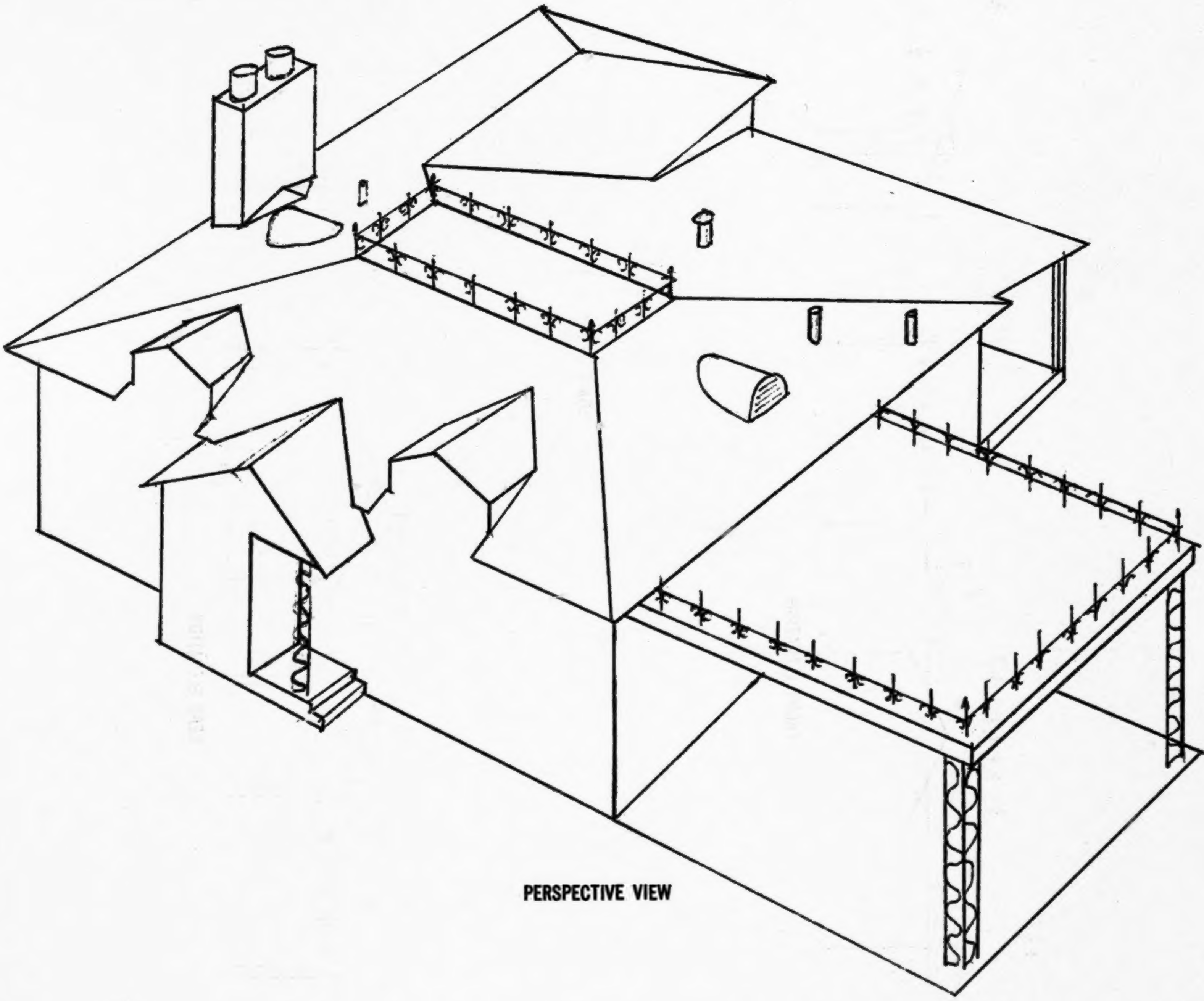
Experienced roofers are soon able to determine roof pitch with reasonable accuracy without measuring.

UNIT D--BLUEPRINT READING

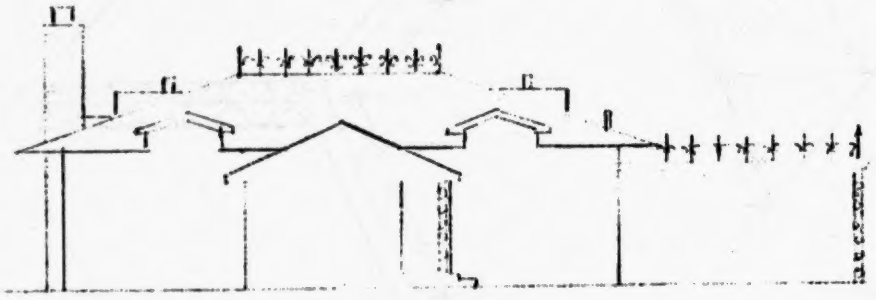
TOPIC 2--ROOF SKETCHING

Exercise

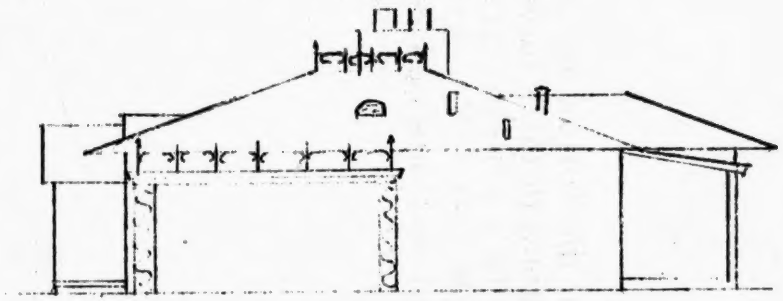
1. Below is a perspective drawing of a house, and on the following page are four elevations of the same building. All superfluous details have been eliminated for the sake of clarity. The next page is a 1/4-in. crosshatch page upon which has been drawn a roof plan of the house. You are to fill in the dimensions on the roof plan by scaling the elevations and counting the crosshatch squares.



PERSPECTIVE VIEW

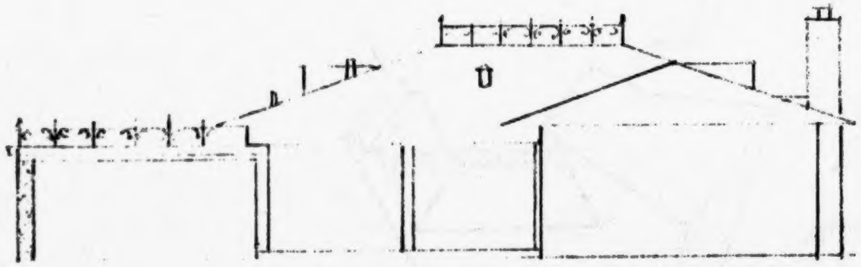


FRONT ELEVATION

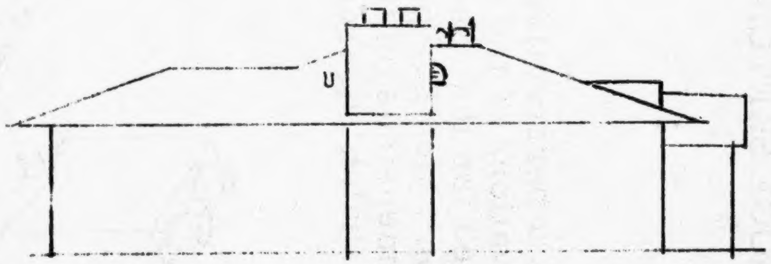


RIGHT ELEVATION

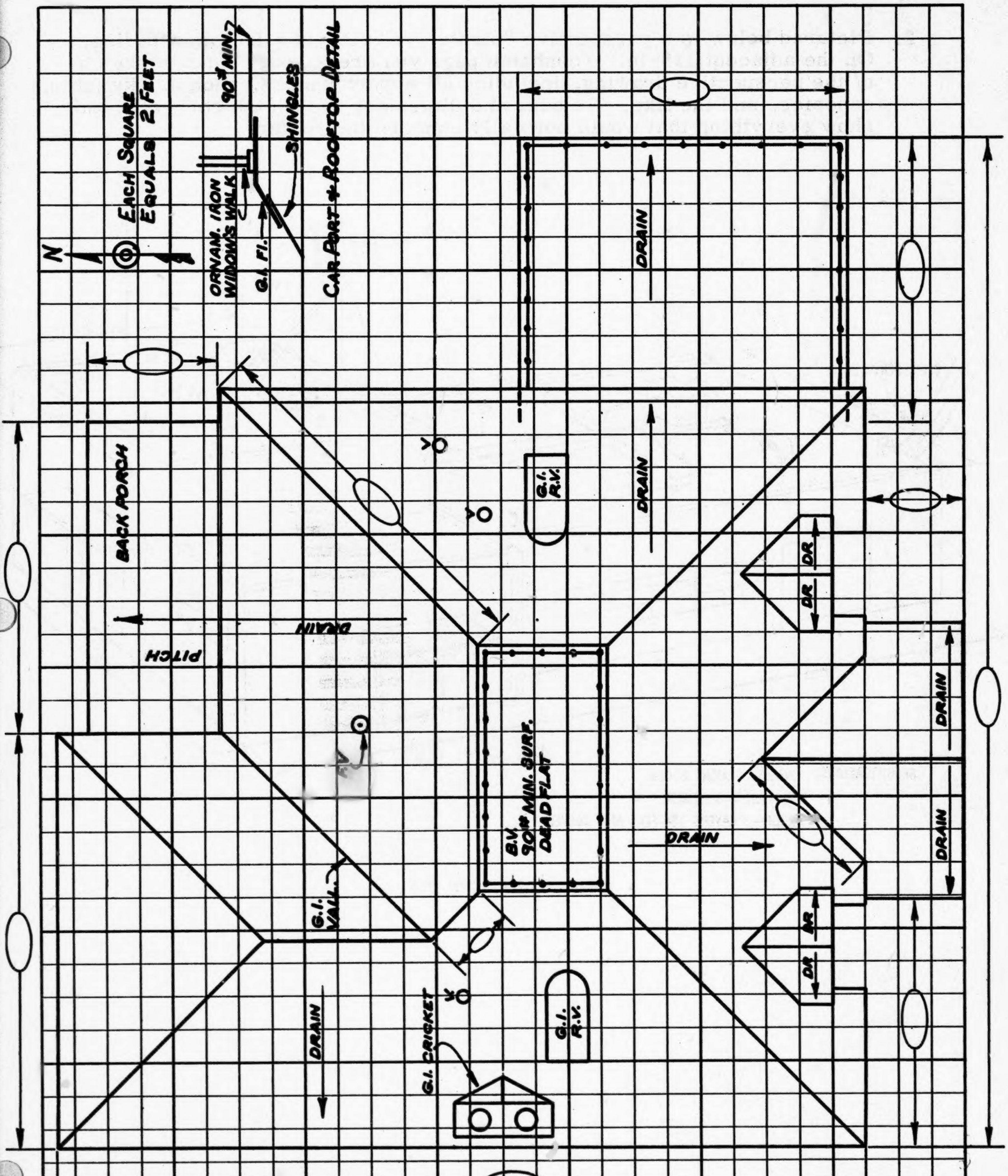
SCALE 1/16" = 1' – 0"



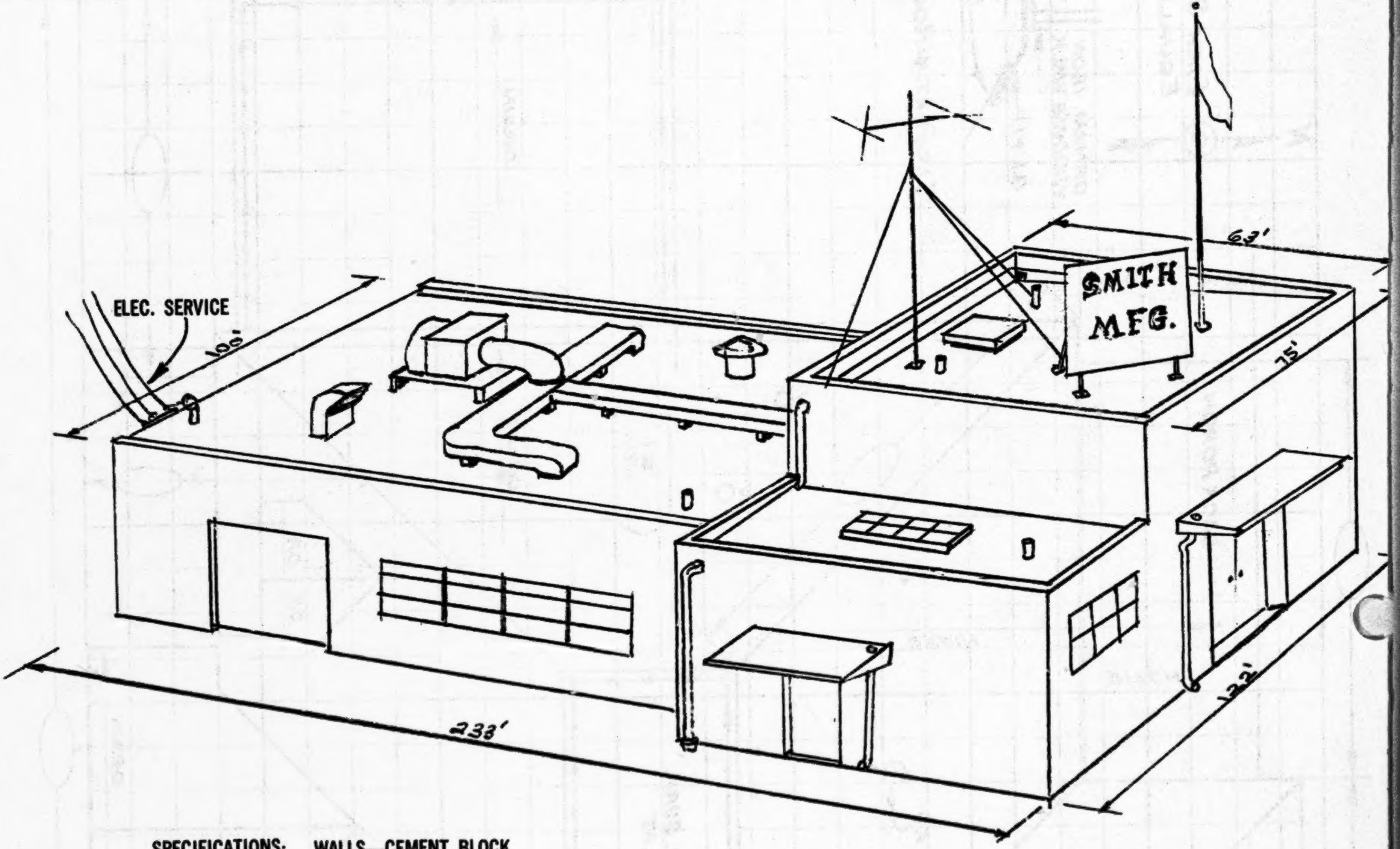
REAR ELEVATION



LEFT ELEVATION


N
EACH SQUARE EQUALS 2 FEET
ORNAM. IRON WIDOW'S WALK
90# MIN.
G.I. FL.
SHINGLES
CAR PORT & ROOFTOP DETAIL
DRAIN
BACK PORCH
PITCH
DRAIN
V
V
G.I. R.V.
DRAIN
DR
DR
DRAIN
DRAIN
B.V. 90# MIN. SURF. DEAD FLAT
DRAIN
G.I. VALL.
DR
DR
V
DRAIN
G.I. CRICKET
G.I. R.V.

2. Pictured below is a perspective "bird's eye" view of a factory building. On the adjacent 1/8-in. crosshatch page you are to make a scale sketch of the perspective drawing, including all appurtenances, such as skylights, canopies, and the like. Be sure and dimension the sketch correctly, and show everything that would normally concern the roofer.



SPECIFICATIONS: WALLS—CEMENT BLOCK
FLASHING—3 COURSE
ROOF—3 LAYERS 15# FELT AND GRAVEL

BIRD'S EYE PERSPECTIVE VIEW

UNIT D--BLUEPRINT READING

TOPIC 3--LINES, SYMBOLS, CONVENTIONS, AND ABBREVIATIONS

This topic, "Lines, Symbols, Conventions, and Abbreviations," is planned to help you find answers to the following questions:

- How can the roofer discriminate between different line weights and learn the purpose of each on blueprints?
- How does one identify and relate the different symbols used on architectural drawings?
- What is the difference between symbols and conventions as used by the architect?
- Why are so many abbreviations used when preparing a set of drawings?

Just as words make up our language, lines, symbols, and conventions make up the language of architecture and put meaning into the drawings. While the roofer needs to know the meaning of all lines, he is required to know only a limited number of the symbols, conventions, and the abbreviations used on blueprints. Consequently, this topic is devoted only to that information necessary to the roofer.

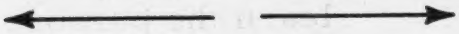
Lines

Bold lines usually surround major portions of a building, section, or detail.

Light lines describe other portions of a drawing.

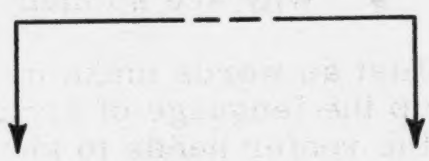
Extension lines are intended to relate one part of a drawing to another at the same position, but in a different view. These lines may also extend to accept a dimension line.

Dimension lines are usually the lightest of all lines on the drawing. Dimensions are written on these lines.

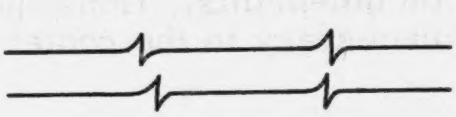


Dotted lines are usually short dashes which indicate a hidden surface. The dots may vary in length, depending on the size of the drawing.

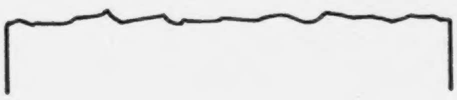
Cutting plane lines are used when a detail is shown for a section of the structure or part of the structure. The arrows point in the direction in which the observer will be looking at the section. "A-A" may be the identification of the section in the drawing.



Long break lines are used to reduce the size of a drawing by cutting out superfluous detail.



Short break lines are used the same as long break lines, but are much shorter in length. They may, however, be used interchangeably.



Center lines indicate the center of any symmetrical object.

Conventions

Conventions are representational drawings of mechanical devices or parts of a building shown in plan or elevation form on the architectural drawings. Some typical conventions a roofer should be able to recognize and identify are shown in Fig. D-1.

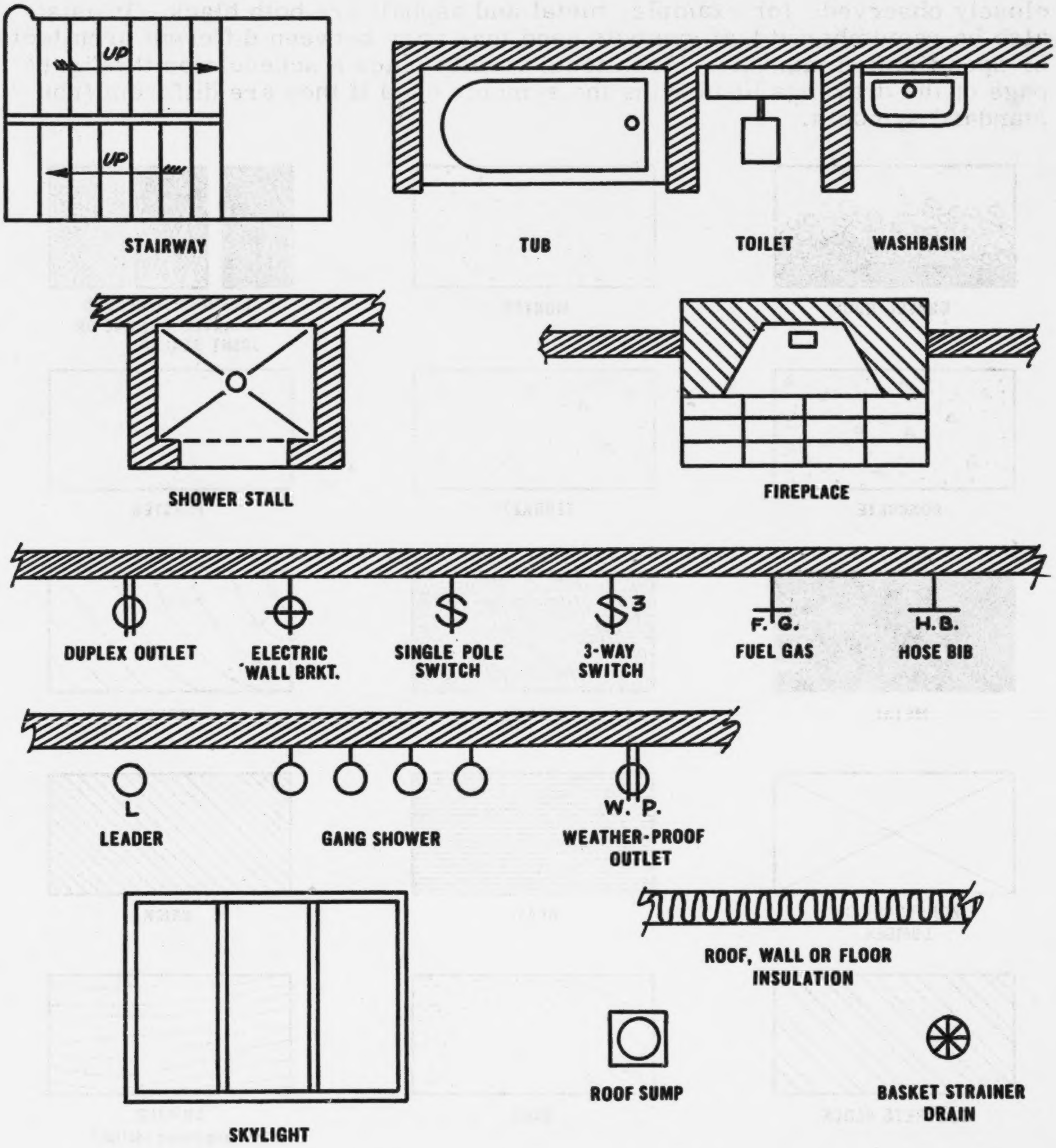

UP
UP
STAIRWAY
TUB
TOILET
WASHBASIN
SHOWER STALL
FIREPLACE
DUPLEX OUTLET
ELECTRIC WALL BRKT.
SINGLE POLE SWITCH
3
3-WAY SWITCH
F. G.
FUEL GAS
H. B.
HOSE BIB
L
LEADER
GANG SHOWER
W. P.
WEATHER-PROOF OUTLET
ROOF, WALL OR FLOOR INSULATION
SKYLIGHT
ROOF SUMP
BASKET STRAINER DRAIN

Fig. D-1. Typical architectural conventions

Symbols

Symbols are representations of cross sections of material only, such as plaster, brick, lumber, insulation roofing, earth, and the like. The symbols pictured in Fig. D-2 are those a roofer is most likely to encounter in his work. Since many of the same symbols are used for various items on an architectural drawing, the context in which the symbol is used must be closely observed: for example, metal and asphalt are both black. It must also be remembered that symbols used may vary between different architects or specification manuals. Architects usually place a schedule on the first page of the drawings identifying the symbols used if they are different from standard symbols.

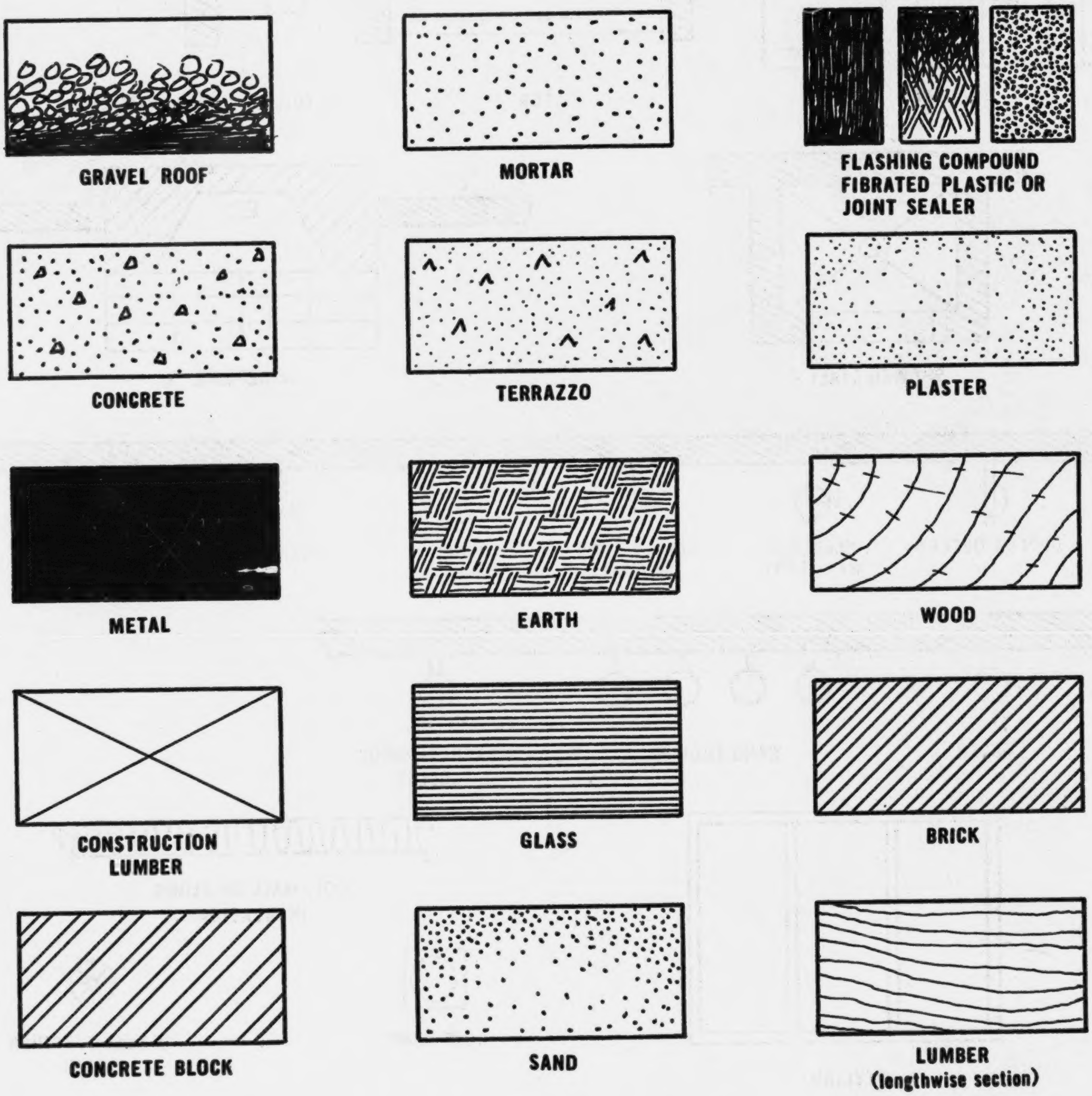

GRAVEL ROOF
MORTAR
FLASHING COMPOUND FIBRATED PLASTIC OR JOINT SEALER
CONCRETE
TERRAZZO
PLASTER
METAL
EARTH
WOOD
CONSTRUCTION LUMBER
GLASS
BRICK
CONCRETE BLOCK
SAND
LUMBER (lengthwise section)

Fig. D-2. Typical architectural symbols

Abbreviations

Abbreviations are used for brevity and to eliminate from the drawing excessive lettering that might result in confusion. The following abbreviations are those the roofer is most likely to encounter in reading blueprints for his work. When reading such drawings, the roofer should keep in mind that a few abbreviations are the same, but connote different things, depending upon the context in which they are used. The same abbreviations will also be used in specifications, code books, and manufacturers' literature.

access area	AA
access door	AD
acoustic	ACST
addendum	ADD
adhesive	ADH
aggregate	AGGR
air conditioning	AIR COND
aluminum	AL
American Institute of Architects	A.I.A.
American Society of Civil Engineers	ASCE
anchor bolt	AB
angle	∠
approximate	APPROX
area drain	AD
asbestos	AB
asbestos roof shingles	ARS
asphalt	ASPH
barrel	BBL
basement	BSMT
beveled	BEV
blueprint	BP
bolts	BT
brick	BRK
bronze	BRZ
building	BLDG
building line	BL
cadmium plate	CD PL
calking	CLKG
cast concrete	C CONC
cast iron	CI
cement asbestos	CEM A
cement asbestos board	CEM AB
cement floor	CEM FL
cement mortar	CEM MORT
ceramic	CER
channel	CHAN
cinder block	CIN BL
circumference	CIRC
cleanout	CO
cleanout and deck plate	CO & DP
concrete block	CONC B
contractor	CONTR
contract	CONT
copper	COP
courses	C
cover	COV
cubic foot	CU FT
dampproofing	DP
detail	DET
diameter	DIA
dimension	DIM
downspout	DS
drain	DR
elevator	ELEV
enamel	E
equipment	EQUIP
estimate	EST
excavate	EXC
expansion bolt	EXP BT
expansion joint	EXP JT
exterior	EXT
extinguisher, fire	F EXT
fabricate	FAB
facing tile	FT
finish	FIN
fireproof	FPRF
fire standpipe	FSP
fitting	FTG
flame proof	FP
footing	FTG
frame	FR
full size	FS
galvanized iron	GI
galvanized steel	GS
gauge	GA
grade	GR
gypsum	GYP
height	HGT
insulation	INS
joint	JT
ladder	LAD
level	LEV
light weight concrete	LWC
light weight insulating concrete	LWIC
linear feet	LIN FT
liveload	LL
membrane	MEMB
minimum	MIN
mounting	MTG
National Board of Fire Underwriters	NBFU
overflow	OVFL
penny (nail size)	D, d
plastic	PLSTC
pounds per cubic foot	PCF
pounds per square	PPS
quarry tile floor	QTF
quarry tile roof	QTR
roof	RF
roof drain	RD
roofing	RFG
saddle	SDL
scupper	SCUP
scuttle	S
seamless	SMLS
sheathing	SHTHG
sheet	SH
siding	SDG
slate	SL
specifications	SPEC
stainless steel	SST
stairway	STWY
temperature	TEMP
vapor proof	VAP PRF
vent pipe	VP
vent stack	VS
waterproof, waterproofing or weatherproof	WP
weephole	WH

UNIT D--BLUEPRINT READING

TOPIC 3--LINES, SYMBOLS, CONVENTIONS, AND ABBREVIATIONS

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. Lines, symbols, conventions, and abbreviations may be called the language of architecture. 1. T F
2. A bold line indicates a section. 2. T F
3. The lightest line is usually the center line. 3. T F
4. A dotted line indicates a hidden plane. 4. T F
5. A cutting plane line refers to a section and detail. 5. T F
6. Abbreviations are used to identify only materials. 6. T F
7. Conventions are symbolic of materials. 7. T F
8. A plan view fireplace is representative of a convention. 8. T F
9. The cross section of gravel on a roof is a convention. 9. T F
10. "G.I. 26 ga." is a military specification. 10. T F

Problem

In the spaces provided below, draw the convention for the item named space.

STAIRWAY

FIREPLACE

SHOWER

DUPLEX ELEC. PLUG

LIGHT BRACKET

HOSE BIBB

In the spaces provided below, draw the symbol for the item named.

EARTH

PLASTIC COMPOUND

BRICK

IRON

CONSTRUCTION LUMBER

WOOD

CONCRETE

TILE

CONCRETE BLOCK

UNIT D--BLUEPRINT READING

TOPIC 4--PLAN VIEWS AND ELEVATIONS

This topic, "Plan Views and Elevations," is planned to help you find answers to the following questions:

- How does one relate a plot plan to a floor plan?
- In what way and for what reason does the roofer "marry" the roof or floor plan to the elevations?
- How does a roofer identify the parts of a roof by referring to the blueprints?
- How can one visualize a three-dimensional object from a two-dimensional drawing?

The ability to orient one's self to the drawings is an essential part of all blueprint reading. In other words, one must be able to "marry" parts, one to the other, such as plans, elevations, sections, details, notes, and specifications. This is necessary to visualize a three-dimensional object in relation to all of its materials and structural features.

For all practical purposes, there are two directions in which to look "mentally" when viewing a set of architectural drawings for a building--downward and horizontally.

Viewing the Blueprints

Plans

A blueprint in which the reader is looking "down" on a building or object is called a "plan view." Theoretically, this expression should be used only when referring to objects viewed from above. Plot plans, foundation plans, floor plans, and top views of details are all "plan views."

Elevations

Elevations are horizontal views of the sides of an object meant to stand upright and should not be identified with plans. (Usually, however, details have "side views" instead of elevations.) Hereafter in this topic a complete set of drawings for a structure will be referred to as "architectural drawings" or a "set of drawings" or "blueprints"--never by the word "plans" alone.

Using Plans and Elevations

The information contained in this topic, together with the Blueprint Reading and Examination Kit (American Technical Society), will help the apprentice roofer become acquainted with the proper use of plan views. He should familiarize himself with the drawings in this topic and the residential prints contained in the kit, as they will be used frequently in this study for scaling, estimating, and so forth. Opportunities are presented in other parts of this unit to make effective use of what is learned from this topic.

Orientation Procedure

Using the Blueprint Reading and Examination Kit, the roofer should perform the following steps with the aid of the plot plan:

1. Determine north direction as the first step in orientation.
2. Note the slope of the property, as this may make a difference as to where to locate the truck and kettle.
3. Note the slope or slopes of the roof, direction of drainage, drains, crickets, gutters, diverters, and the like. This information will provide a guide for loading of the roof.

NOTE: A plot plan includes orientation data, overall dimensions, grades and drainage, walks, streets, and the like.

The roofer should take the following steps through comparing the floor plan with the roof plan:

1. Note how the roof may cover porches not shown on the floor plan.
2. Note how hips, ridges, and valleys are superimposed in long, light, dash lines on the floor plan. (The points at which these lines cross may be considered areas of good support that should be utilized when loading the roof.)
3. Note exposed ceiling areas where no attic exists. (This will provide a guide for proper length of nails, the need for rosin sheet, and so forth.)

While comparing each side of the floor plan with the corresponding elevation view (on the elevation sheet) by holding them adjacent to and in line with each other, the roofer should take the following steps:

1. Note how the ridges, hips, eaves, and valleys on the floor plan correspond to those same points on the elevation.
2. Note how the chimneys and windows are placed on the floor plan and on the corresponding elevations.

3. Determine from the foundation plan if a floor membrane is needed. Look for other points on the prints for additional areas that might require waterproofing--shower pans, planters, and the like.

At the end of Unit F is a set of special drawings of a factory building (Figs. F-38 through F-44). These prints are designed to acquaint the apprentice roofer with those parts of a set of blueprints pertaining specifically to the roofing trade.

Subsequent topics will outline how to identify these building "parts" in an actual set of architectural drawings. (Although blueprints do not usually include a perspective or other pictorial view, one is included with this set to provide for better orientation in the initial stages of blueprint reading.)

UNIT D--BLUEPRINT READING

TOPIC 4--PLAN VIEWS AND ELEVATIONS--Study Guide and Checkup

Study Guide

Using the drawings at the end of Unit F, perform the following exercises:

1. **Scale the dimension lines (1 through 11) in Fig. F-42 and write these dimensions in the numbered spaces below:**

   1.________

   2.________

   3.________

   4.________

   5.________

   6.________

   7.________

   8.________

   9.________

   10.________

   11.________

2. **Scale the width of the chimney.**

3. **Scale the length and width of the skylight.**

4. **Determine the total distance of the span of the barrel roof.**

5. **Determine the length of the sawtooth rafter.**

6. **Scale the dimension lines in Fig. F-43.**

7. **Determine the height of the west wall.**

8. **Determine the height of the water tank from the ground.**

9. **Compare the foundation perspective view, Fig. F-39, with the foundation plan, Fig. F-41.**

10. **Compare the plot plan, Fig. F-40, with the roof plan, Fig. F-42, and note the elimination of detail.**

11. **List three reasons why the roofer should be familiar with a plot plan:**

12. Determine how many protrusions appear on the roof, and list those with which the roofer is concerned:

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The term "plans" refers to a complete set of architectural drawings. 1. T F
2. To visualize and understand the entire scope of a set of blueprints, one must be able to "marry" the plans, elevation, sections, and details, each to the other. 2. T F
3. Plot plans show the location of the building on the lot, the general outline of the structure, and sections of the roof construction. 3. T F
4. Plan views show the elevations of an object. 4. T F
5. Plot plans convey information essential to the roofer in determining materials needed for the job. 5. T F
6. Floor plans will provide the roofer with information needed to determine where roof supports are located. 6. T F
7. Roof plans and elevations must be "married" to determine the shape and configuration of a roof. 7. T F

8. There is no need for a roofer to concern himself with the interior construction of a house. 8. T F

9. The true length of hips can be determined by reference to a plan view. 9. T F

10. Pictorial views are not usually included in a set of architectural drawings. 10. T F

11. In order of sequence, plot plans always precede floor plans in a set of blueprints. 11. T F

12. Perspective views are an essential part of any set of blueprints. 12. T F

13. Section indications may be placed on any part of a building where deemed necessary. 13. T F

14. Roof plans contain all the information a roofer needs to perform the roof job. 14. T F

15. A plot plan is of little interest to the roofer, because he is concerned only with roof configuration. 15. T F

UNIT D--BLUEPRINT READING

TOPIC 5--SECTIONS AND DETAILS

This topic, "Sections and Details," is planned to help you find answers to the following questions:

- How are details located in a set of blueprints?
- What is the method used to interpret sections and details?
- How may sections and details be identified?
- What is the difference between a section and a detail?

A roofer cannot always perform efficiently unless he is able to read blueprints. He should be able to "marry" plan views with elevations, and he must also know how to match section and detail identification numbers with their respective sections and details appearing on other pages of a set of drawings. Although an apprentice may have occasion to use this knowledge only infrequently, he should still be prepared for such opportunities when they do arise.

When an architect prepares the drawings and specifications for a structure, he determines the type of roof and its application entirely from the following sources:

- Code requirements
- Roofing manufacturers' specification manuals.(Manufacturers' specification writers and engineers are often consulted on special jobs.)
- Recommendations of roofing contractors

Since few architects are experienced roofers, they must rely on the judgment and experience of those who work in the roofing field. Because of this, the roofer should be alert to conditions on the job that may make the architect's recommendations unsuitable. When this occurs, the matter should be called to the attention of the general contractor, supervising inspector, or the architect. In most cases, the roofer will first inform his own employer, the roofing contractor.

Definition of Section and Details

A section is a "cut" run through any item (a mechanical device, building structure, or the like) which reveals how the item is constructed. To put it another way, a sectional view is one in which a portion of the object is assumed to be removed to reveal the interior details.

A detail may be a combination of a section and other extraneous items which reveals how the completed item is constructed. This drawing may be isometric, perspective, or oblique--showing three sides--while the section usually reveals only one viewer side.

Locating Sections and Details

On minimal drawings of residences, the sections or details will be identified as "Section A-A," "Section B-B," and so forth, since, at most, only ten to fifteen drawings are included, covering five or six pages of such drawings. On drawings of large structures, however, there may be fifty to a hundred pages (or even more), plus additional shop drawings and accompanying change orders from the architect. This requires a different and more complex indexing method.

Examples of sections and details are illustrated in Topic F, Figs. F-1 through F-38.

Identification

An east elevation of a guard entrance station is shown in Fig. D-3. A small hexagon printed just above the roof contains the notation "15-A6." In this case, "15" refers to the detail or section number, and "A6" indicates the page on which it is to be found in the set of blueprints. The section in question is shown in Fig. D-4, and is identified with another hexagon labeled "15-A6" over "A6," which verifies the proper page and section.

Shown in Fig. D-5 is a corner of a typical sheet from an architectural drawing that might be used for a large building. This corner contains a combination of various numbers and letters used for identification purposes. It will be noted that the sheet number is "A-6," referred to in Figs. D-3 and D-4. The sheet number is the most important reference with which the roofer is concerned.

In addition to the sheet number, the main items of interest to the roofer are: (1) the building number (9/1, in this case), which is extremely important when more than one structure is included on a building site; and (2) the plan number, which should be checked carefully, since a different set of prints may occasionally be inserted for purposes of new additions.

Variations of the foregoing are occasionally found in this "title square," but the apprentice will have no trouble understanding the information given, providing he is familiar with the basic system.

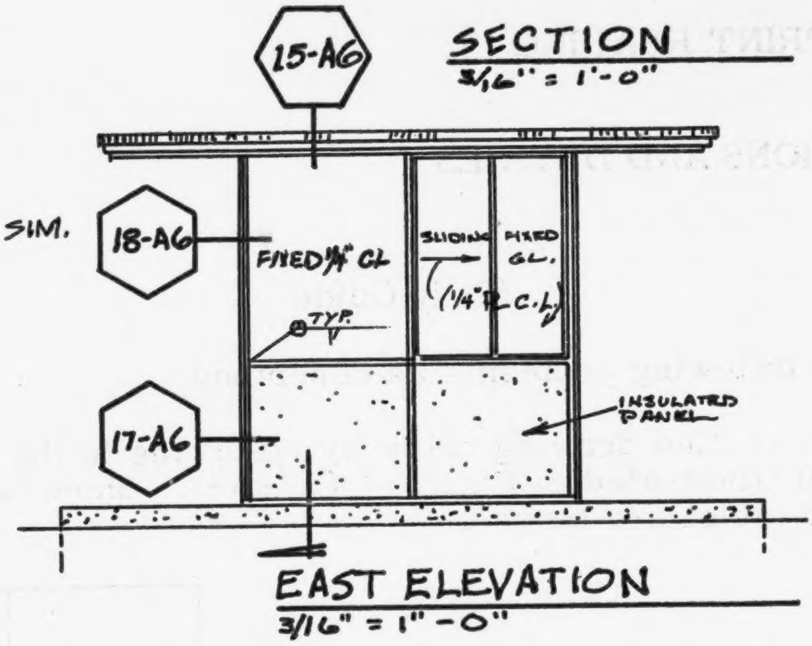

15-A6
SECTION
3/16" = 1'-0"
SIM.
18-A6
FIXED 1/4" GL
SLIDING
FIXED GL.
(1/4" R.C.L.)
TYP.
INSULATED PANEL
17-A6
EAST ELEVATION
3/16" = 1" -0"

Fig. D-3. Typical elevation view of guard station

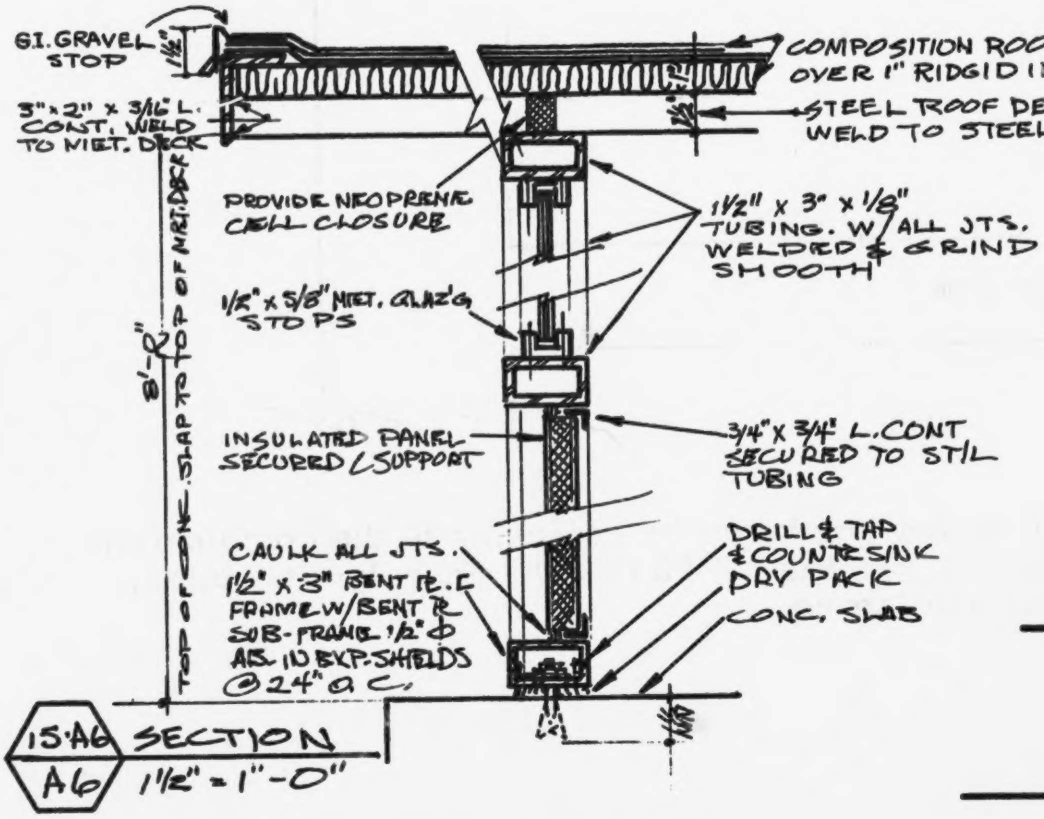

GI. GRAVEL STOP
1 1/2"
COMPOSITION ROOFING OVER 1" RIDGID INSULATION
3" x 2" x 3/16" L. CONT. WELD TO MET. DECK
STEEL ROOF DECKING WELD TO STEEL TUBE FRAMING
PROVIDE NEOPRENE CELL CLOSURE
1 1/2" x 3" x 1/8" TUBING. W/ ALL JTS. WELDED & GRIND SMOOTH
1/2" x 5/8" MET. GLAZ'G STOPS
8'-2"
TOP OF CONC. SLAB TO TOP OF MET. DECK
INSULATED PANEL SECURED L SUPPORT
3/4" x 3/4" L. CONT SECURED TO ST/L TUBING
CAULK ALL JTS.
1 1/2" x 3" BENT PL. C FRAME W/BENT PL SUB-FRAME 1/2" Φ AB. IN EXP. SHIELDS @ 24" O.C.
DRILL & TAP & COUNTERSINK
DRY PACK
CONC. SLAB
15·A6
A6
SECTION
1 1/2" = 1" -0"

Fig. D-4. Typical section relating to elevation

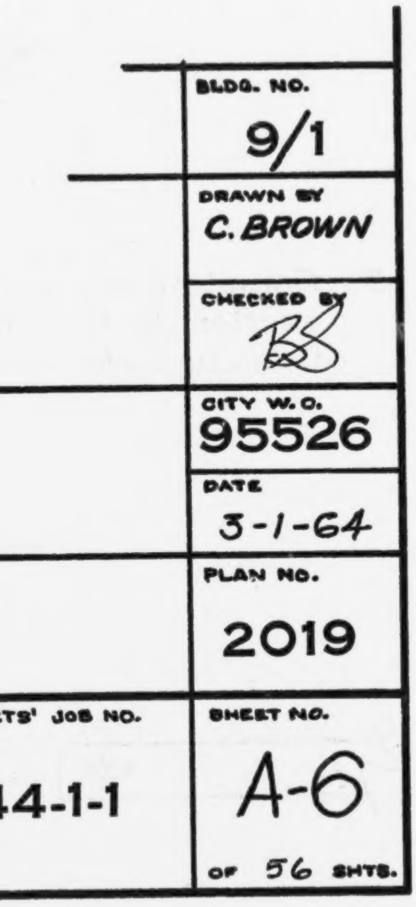

BLDG. NO. 9/1
DRAWN BY C. BROWN
CHECKED BY BS
CITY W.O. 95526
DATE 3-1-64
PLAN NO. 2019
ARCHITECTS' JOB NO. 344-1-1
SHEET NO. A-6
OF 56 SHTS.

Fig. D-5. Identification numbers on architect's drawings

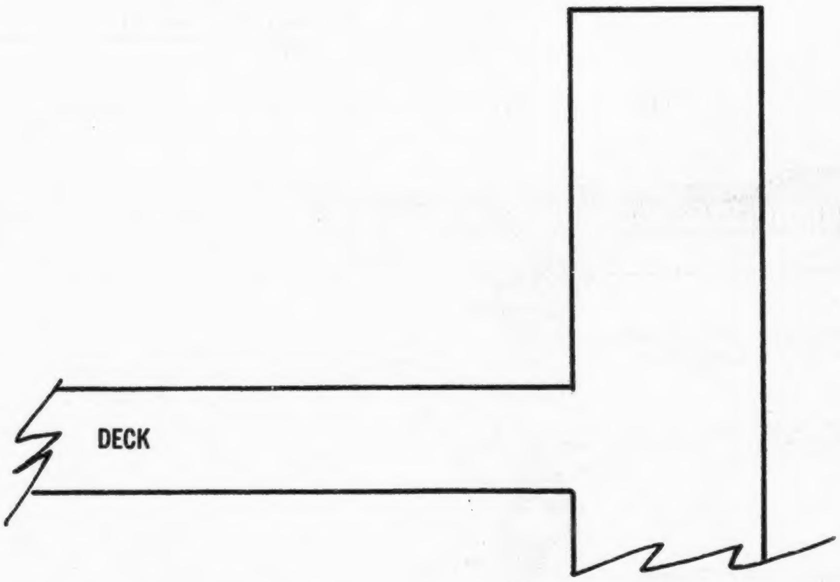
UNIT D--BLUEPRINT READING

TOPIC 5--SECTIONS AND DETAILS

Study Guide

Solve each of the following problems as described:

1. Complete the section drawing below by referring to the combination section detail illustrated in Fig. F-1 (A^2-A^2). Show how all plies, flashing, and metal are lapped.

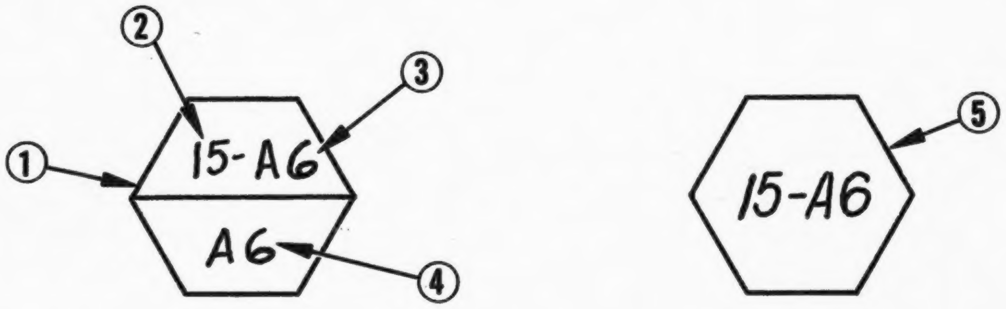


2. Complete the section drawing below by referring to the combination section detail illustrated in Fig. F-15 (N-N). Show how all plies, flashings, and metal are lapped.

3. Using Fig. F-42 (Unit F), locate each of the sections and details appearing there by referring to Figs. F-1 through F-38.

4. Using the two guidelines drawn below, reproduce the section of the guard station roof edge shown in Fig. 2 in this topic. Execution, accuracy, construction, proper scale, and clarity will be considered in evaluating the drawing.

Answer the following five questions relating to the illustration below:



5. Number (1) is found on the ____1____ or detail. 1. __________

6. Number (5) is found on the ____2____ or floor plan. 2. __________

7. Number (4) indicates the ____3____ verification. 3. __________

8. Number (2) indicates the ____4____ or ____5____ number. 4. __________

9. Number (3) indicates the ____6____ in a set of blueprints. 5. __________

UNIT D--BLUEPRINT READING

TOPIC 6--ROOFER'S TAKEOFF SKETCHES

This topic, "Roofer's Takeoff Sketches," is planned to help you find answers to the following questions:

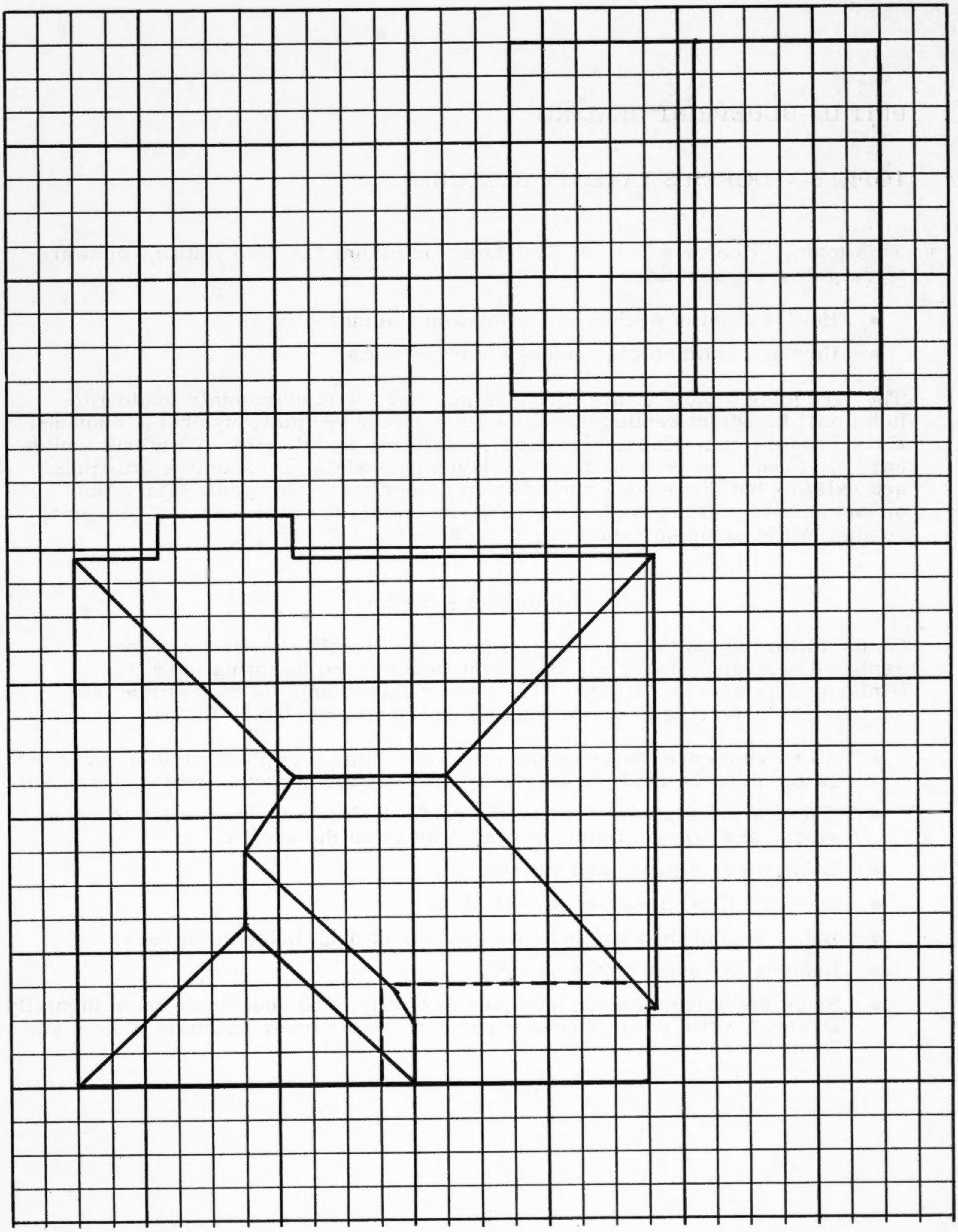
- How is a set of architectural drawings actually used?
- How are estimator's sketches correctly made?

The preceding topics of this unit have outlined the fundamentals leading to functional blueprint reading needed by the roofer -- lines, symbols, conventions, dimensions, plans, elevations, sections, and details. Previous topics have also required the making of sketches of models, perspective drawings, and existing buildings constructed from blueprints. This topic offers the opportunity to test the roofer's ability and knowledge in the field of blueprint reading while using an actual set of architectural drawings.

Estimator's Sketches

On the following page are roofing estimator's sketches made from the assigned reference material, Blueprint Reading and Examination Kit (American Technical Society). The roofer must complete the estimator's sketches by referring to the prints and the statements which follow:

- As no vents are shown on the roof plan of the plot plan, further investigation must be made to determine the number of vents and their location.
- There are ten projections on the roof. Refer to the prints for location, sizes, and types. Detail and label these on the sketch.
- Label hips, ridges, and valleys.
- Show the flow direction of each slope.
- Label the porches and indicate the type of deck involved in each case.
- Indicate the scale of the sketch.
- Study the blueprints and sketches carefully, and coordinate them mentally. Draw or write in all details necessary for a proper estimate to be made from the reference print.



unit

e

Estimating

TOPIC 1--TYPES OF BUILDINGS, ROOFS, AND ZONES

This topic, "Types of Buildings, Roofs, and Zones," is planned to help you find answers to the following questions:

- What is the Uniform Building Code, and where is it used?
- How do zoning regulations affect the roofer?
- How many types of zones are there, and what purpose do they serve?
- How many roof classifications are there, and where may they be used?

The work of the building industry affects the life of every individual in the nation. Man must have shelter from the elements to survive, and an adequate building structure with a good roof is essential to his life, whether at home or at work. To achieve some semblance of regulations and uniformity, certain rules and regulations have been adopted to become part of a uniform building code. For the most part, building codes are designed to promote the welfare of the public. A roofer should have an understanding of existing codes and know where to go to secure information in regard to them.

Building Codes

Most cities have adopted a building code and a set of zoning regulations for the protection of the public, for certain regulation of the construction of buildings, and for the purpose of protecting investments. Many small towns and counties that have not adopted a local building code follow the Uniform Building Code prepared by the International Conference of Building Officials. (In most instances, the code is amended or revised to meet local conditions.)

A building code is a set of laws and rules governing the construction, repair, and demolition of building structures. These codes have grown gradually and have been improved as time passed and necessity warranted.

A pamphlet entitled Dwelling House Construction has been prepared as a quick reference for information concerning code requirements for residential construction. The information contained in this pamphlet is by no means complete, but it contains most of the information needed for this type of structure.

The Uniform Building Code

The Uniform Building Code is the result of an attempt on the part of those involved in the building and contruction field to standardize building laws and rules on a national basis.

The Uniform Building Code classifies buildings in accordance with several different principles:

1. Their use or the character of their occupancy, such as residences, theaters, stores, churches, and the like. These classifications are called "groups" and are categorized as follows:

Group	Type of occupancy
A	Large assembly buildings
B	Small assembly buildings
C	Schools
D	Jails
E	Public garages, planing mills, storage places for flammable materials
F	Stores, service stations
G	Factories
H	Hotels, motels, apartment houses
I	Dwellings
J	Private garages, fences over 6 ft. high

2. Types of buildings, of which there are five:

Type	
I	Fire-resistant
II	Heavy timber construction
III	Ordinary masonry
IV	Light incombustible frame
V	Wood frame

(Heavy timber construction has a much higher rating than wood frame construction. One reason for this, of course, is strength; another is the hours of fire resistance a heavy timber has as compared with smaller-dimensioned material.)

Another type of classification, one used principally for insurance purposes, employs the terms "Class A," "Class B," "Class C," and so on. These terms are often confused with the foregoing category and used as if the two were interchangeable, which is incorrect. This erroneous usage should be avoided because, correctly used, the terms "Class A" and the like indicate only the fire-resistant quality of parts of a building--i.e., materials used in construction, partitions, doors, roofing, and so forth.

Zoning

Most cities today have planning commissions established to help ensure orderly growth and development through the control of building placement, density, and use of areas in which various types of structures are permitted to be built. Zoning regulations are established to protect the health and safety of the people of the community.

The following excerpt from a typical code defines in some detail the purpose of zoning:

> The purpose of this Article is to consolidate and coordinate all existing zoning regulations and provisions into one comprehensive zoning plan in order to designate, regulate, and restrict the location and use of buildings, structures and land, for agriculture, residence, commerce, trade, industry, or other purposes; to regulate and limit the height, number of stories, and size of buildings and other structures, hereafter erected or altered; to regulate and determine the size of yards and other open spaces and to regulate and limit the density of population; and for said purposes to divide the City into zones of such number, shape, and area as may be deemed best suited to carry out these regulations and to provide for their enforcement. Further, such regulations are deemed necessary in order to encourage the most appropriate use of land; to conserve and stabilize the value of property; to provide adequate open spaces for light and air, and to prevent and fight fires; to prevent undue concentration of population; to lessen congestion on streets; to facilitate adequate provisions for community utilities and facilities such as transportation, water, sewerage, schools, parks, and other public requirements; and to promote health, safety, and the general welfare, all in accordance with a comprehensive plan.

The building zones designated in most cities throughout the United States are generally uniform. The following is a list of various zones and their approved abbreviations:

1. A1, A2 - Agricultural
2. RA, RS - Suburban
3. RE - Residential estate
4. R1 - One family
5. R2 - Two family
6. R3, R4, R5 - Multiple dwelling
7. P - Automobile parking
8. PB - Parking building
9. CR, C1 - Limited commercial
10. C2, C3, C4, C5 - Commercial
11. CM - Commercial manufacturing
12. M1 - Limited industrial
13. M2 - Light industrial
14. M3 - Heavy industrial
15. RD - Research and development

Fire zoning. All large cities are divided into fire zones. These zones are designated in the Uniform Building Code as Fire Zones Nos. 1, 2, and 3. Although the occupancy of a building is a controlling factor in determining its type of construction, fire zoning is equally important. For example, a four-family apartment might be built Type V in one fire zone, but--for the same occupancy--would be built Type I or Type II in another fire zone.

Types and Classifications of Roofs

Roofs may be classified into two general types--fire retardant and ordinary. Fire-retardant roofs are designed for use on all business and commercial buildings. Ordinary roofs are used on apartments (depending upon the fire zone involved), dwellings, and other small buildings. Fire-retardant roofs are required by code on all buildings that fall under the following "occupancy" classifications: Groups A, B, C, D, E, F, and G. Ordinary roofs may be used on buildings in groups H, I, and J.

Underwriter Laboratories has established specifications for fire-retardant roofs, designated as "Class A" and "Class B." Ordinary roofs are designated as "Class C." All roofing delivered from the factory with a UL label is "Class C material" (not to be confused with a "Class C" roof). "Class A" and "Class B" roofs are produced by wrapping together certain combinations of felts, capsheets, or gravel to produce the requirements established for the class of roof desired. (Some fiber glass shingles and asbestos shingles are acceptable to use on a fire-retardant roof.)

The Federal Housing Administration

The Federal Housing Administration (FHA) is a government agency which guarantees to lenders the payment of home loans. The loan itself may be made by any private lending institution, in accordance with rules laid down by the agency. As a prerequisite to such guarantee, the FHA has laid down certain minimum standards of construction. This provision lessens (though by no means eliminates) the possibility of the FHA being responsible for poorly-constructed or substandard houses. Whenever the FHA standards differ from those set up by state, county, or city governments, the higher standards must prevail.

FHA minimum construction requirements vary from one part of the country to another. Whenever "Minimum Property Standards" are referred to in this workbook, it relates to the code applicable in the reader's geographical area. Most cities maintain a building department for the assistance of the public, and information regarding building regulations and local ordinances may be obtained at such places. The FHA also maintains throughout the state offices staffed by representatives who can supply all needed information on construction requirements.

Changes

The roofer must be constantly alert to changes in building code requirements, as building zones are continually being added and changed as population increases and new industries are developed. Especially important to watch for are new zone designations for such industries as atomic power plants and industrial plants using radioactive materials. These operations may affect changes in operations, methods, or materials used in roofing.

Study Assignment

Uniform Building Code. Pasadena, California: International Conference of Building Officials, 1964, pp. 47-50 and 298-308.

Topics for Discussion

Be prepared to discuss the following topics if asked to do so:

- What is the "Uniform Building Code" and where is it used?
- Why is it necessary to have fire zones?
- What constitutes a fire-retardant roof?
- Who determines the qualifications for a fire-retardant roof?
- Are all building code requirements similar for fire-retardant roofs?
- Do building code requirements help or hurt the roofer?
- Does a fire-retardant roof really help to contain a fire?
- What are the beneficial effects of proper zoning?
- What is the difference between general zoning laws and fire zoning laws?
- Is a fire-retardant roof considered fireproof?
- Why should a roofer be familiar with zoning laws?

UNIT E--ESTIMATING

TOPIC 1--TYPES OF BUILDINGS, ROOFS, AND ZONES - Study Guide and Checkup

Study Guide

After you have studied the material in this topic and in the assignment, answer the following questions:

1. List five residential situations in which zoning or codes specify certain roofs must be installed:

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

2. List five different industries which, because of their nature, require different types of roofing materials:

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. Any type of roof may be installed in Fire Zone No. 1. — 1. T F

2. A building constructed in Fire Zone No. 2 requires a fire-retardant roof. — 2. T F

3. Class "C" material is not recommended for use on a fire-retardant roof. — 3. T F

4. Buildings on which ordinary roofs are permitted are included in Groups H, I, and J. — 4. T F

5. A No. 2 Fire Zone usually includes business streets and neighborhood districts. 5. T F

6. A class "C" roof is a fire-retardant roof. 6. T F

7. A No. 3 Fire Zone is usually a residential district. 7. T F

8. Building codes are adopted primarily to protect the public. 8. T F

9. Ordinary roofs may be installed on apartment houses. 9. T F

10. Double-coverage composition shingles are acceptable for use on a fire-retardant roof installation. 10. T F

11. All cities are required to abide by the Uniform Building Code. 11. T F

12. The Uniform Building Code classifies structures according to their occupancy. 12. T F

13. A dwelling is usually a Type V construction. 13. T F

14. Heavy timber construction has a high fire rating. 14. T F

15. The fire zone in which a building is or will be situated can determine the class of roofing material used. 15. T F

UNIT E--ESTIMATING

TOPIC 2--PRINCIPLES OF ESTIMATING

This topic, "Principles of Estimating," is planned to help you find answers to the following questions:

- What is involved in the estimating process for roof jobs?
- What short cuts should be used in estimating?
- What mathematical calculations are necessary in estimating?
- How do specifications and contracts affect job estimates
- What is a bonded roof, and how does this enter into estimating?

Roofing jobs can be estimated with the help of many things--handbooks, tables, pitchcards, rules of thumb, and the like. But the roofer who learns at the outset to use mathematical procedures for calculating areas, linear feet of material, and so forth and who is confident of his ability to make these calculations may later feel free to take some of the shortcuts of experienced estimators. It is often necessary--and usually a sound idea--to recheck estimates, especially if large amounts of money are involved.

The ability to estimate correctly is of great value to the journeyman and apprentice alike. A man with such ability will have a constant awareness of the needs of a job, which he can duly report to his foreman or employer, thus eliminating extra trips and thereby reducing costs. This ability also leads toward advancement into other phases of work in the roofing trade.

Specifications

Before any roofing jobs can be estimated (a process sometimes called a "take-off"), the roof specification for the job should be checked. This procedure reduces the possibility of making errors when the time comes to determine the proper material, fastening methods, and so forth. All too frequently, contractors who are low bidders on a job find out too late the specifications were not interpreted correctly.

Architectural drawings and the specifications on a job, taken together, serve several functions:

- They provide an equal basis and a set of standards upon which all roofing contractors can bid a job.

- They supplement each other; for example, model designations, serial numbers, textures, finishes, and the like are generally too numerous to be included on the drawings. Using both items, requirements can be set forth in greater detail for an entire job.
- They provide a firm easily understood record of all requirements, upon which to establish agreements between contractor and client as well as a good base for the settling of disputes.
- They establish a legal basis for supplemental authorizations, divisions of responsibility, and other relationships.
- They provide a satisfactory basis for negotiating contracts.

Specifications indicate specific areas of responsibilities regarding performance, quality, and completion time for all subcontractors. Specifications are required for any job on which loan commitments are to be made because lending agencies demand complete preplanning of a structure so that definite costs may be determined.

In residential construction, specifications are legal and binding, but they are not usually as complex as those prepared for large structures. Every set of plans for a residence should have specifications provided, but only a few city building departments require this. Home building jobs having FHA guaranteed loans, however, are required to have written specifications which reflect the minimum standards demanded by the agency. When a loan commitment is sought under these conditions, several sets of prints and specifications are usually needed. The prints and specifications should always be available on the job site, regardless of the stage of completion.

Contracts

A building contract is a binding agreement between a client and a contractor to perform a job in accordance with the blueprints and specifications issued for that job.

On most large, complex building jobs, the specifications are studied and contracts negotiated by attorneys, and this frequently involves complicated legal procedures. Very often thousands of dollars are expended by those concerned before the contract is finally signed, and a contract attorney is maintained on a retainer basis for the duration of the job.

The roofing contractor, however, has to deal only with the party with whom he has a contract (usually the general contractor) to clarify such matters as material needed, methods of application, and the like. It is the responsibility of the general contractor to clear such matters with the architect or other specification writer.

Certain conditions governing contracts are customarily observed on all building jobs. These conditions cover such items as insurance, bonding, job-site facilities, owner-contractor relationships, public safety, and so forth. A summary of conditions generally involved has been published by the American Institute of Architects and has received wide approval from contractors' associations.

A basic understanding of the responsibilities of both the architect and the contractor is important to the roofer if he is to carry out his job effectively.

Bonded Roofs

A roof that is bonded by the manufacturer is one that is guaranteed for a stipulated length of time (usually 10 or 20 years), providing the roof is applied in strict accordance with the manufacturer's specifications.

Such a warranty is a form of insurance and costs a certain amount of money per square of roofing. This cost, borne by the customer, will run about $1.75 per square over and above the cost of material and labor. If roof repairs are required during the warranty period, the manufacturer's costs will run about five or six dollars per square. If, however, it is found that the roofing material was not installed as stipulated by the manufacturer, the cost of repair falls directly on the roofing contractor who did the job.

As a general rule, if no problems occur with a roof within the first two years, it is reasonable to assume the roof will remain satisfactory for the remainder of the warranty period. Bonded specifications are usually referred to by number in the manufacturer's specification manual, and the roofer must interpret the requirements in a manner that will enable him to apply the roof to the satisfaction of the manufacturer. (An architect's specification may refer also to the manufacturer's manual for bonded recover work.)

Factors to Consider When Estimating

An estimator's approach to his job is governed by the following situations:

- When a new roof is to be installed on an unroofed existing structure
- When an old roof is to be recovered or repaired
- When a roofing job must be estimated for a building not yet constructed

To do a proper job of estimating on either new or on recover work, the estimator should know the number of squares his crew will be able to lay in a given number of hours. He must also be familiar with whatever problems may exist regarding working space, weather conditions, and the like. (Long range weather forecasts are available and should be considered in the contractor's schedule.)

The estimator must decide what method to use when "loading the job," and whether or not the crew will encounter loading obstacles such as metal flashing, air conditioning units, signposts, and similar objects.

When quantities of material needed for a job must be determined before the structure is built, these figures are estimated from the plans, sections, details and specifications. The specifications are the most important in this type of estimating.

(NOTE: Architects are not experienced roofers and sometimes make errors on details which the estimator should note. Such errors should be called to the attention of those in authority on the job, but there is a "line of command" that should be observed--normally from the roofing contractor to the general contractor, then to the architect. No major change should ever be made without going through channels.)

The procedure for estimating a roof job on an existing structure is basically the same whether the structure is new or old, except that a new deck requires a more thorough inspection before the roofing operation can commence. Both types can and should be measured, providing the roof pitch in each case is such that climbing upon the roof is not dangerous. (See Safety Rules, Unit D, Topic 1.)

Estimating recover work is more difficult than estimating new work in at least one respect--it is more difficult to detect flaws in an existing roof because such flaws can be covered up by the original roof. The age of an old roof and the number of previous applications should be determined before any estimate is started. Excess weight on an old roof, brought about by the new application, can often cause serious structural damage; the building will sometimes settle, causing plaster to crack, or the roof can even collapse.

When large recover jobs must be estimated, it may be necessary to study the original architectural drawings as well as visit the job site.

To estimate a roof job on a structure not yet built, however, requires that the roofer interpret the architect's drawings and specifications. If specifications are not available (other than notations on the roof plan or job order), sound judgment on the part of the roofer is required to select the right materials and best methods for the job. To do this, the estimator must be familiar with the following items:

- Applicable building codes
- Materials to be used
- Available equipment
- Methods
- Access to the roof
- Time required for the job
- Overhead costs

(NOTE: The estimating of wages and overhead will not be included in this workbook, since it involves too much additional study.)

Factors Influencing Estimates

Roofing contractors must be realistic in estimating jobs. They can perform a "quality" job or a "competitive" job, depending on what the customer wants. The contractor must remember that he is in competition with others, and his price, in most cases, must be competitive--something that is possible only through careful and thorough control of his costs of operation. He may want to do the best possible job in every instance--and this is a worthy goal--but he would soon be out of business if he bid all jobs without considering his competition. This is a fact of life that everyone in the trade must face.

It is still possible, however, for the roofer to perform each job in the best possible manner regardless of the job specifications or the contractor. A good roofer who knows how to do a quality job, using the correct procedure, can soon learn to do his work rapidly and with top quality.

Roofing Estimate Forms

Estimate forms are available from manufacturers for the convenience of contractors. Some contractors print their own estimate forms, and Fig. E-1 is an example.

All estimate forms call for the same basic information, but some may be organized differently from others. The estimator should always use a sharp pencil and print clearly when filling out the forms. Since this form serves as a form of communication concerning a job, nothing should be left out that could be considered an essential point of information. A checklist should also be used to further aid in compiling a complete estimate. A separate checklist for each type of roof should be compiled.

Quantity Survey Service

Roofing contractors may subscribe to a Quantity Survey Brief, which provides the essential roof plans, elevations, details, and specifications--all the written and geographic information required to prepare an estimate. This material is available on jobs under construction and on those jobs not yet underway. Having been checked and rechecked, these briefs are accurate except for change orders from the architect. Prior to starting work, however, the contractor or estimator should inspect the structure and review the change orders, as he may have to modify the bid, the material order, or the labor requirements.

Study Assignment

J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products, pp. 91-97.

ROOFING CONTRACTORS' INSPECTION RECORD

EST. NO. ________
JOB NO. ________
DATE ________

NAME OF BLDG. ________ PHONE ________
ADDRESS ________
OWNER ________ PHONE ________
ADDRESS ________
CONTACT ________ PHONE ________
____

TYPE OF BLDG.: ____ STORIES
- Office ________
- Factory ________
- Warehouse ________
- Garage ________
- Commercial ________
- Store ________
- Hotel ________
- House ________
- Other ________

ROOF STRUCTURE:
- Wood ________
- Concrete ________
- Gypsum ________
- Steel ________
- Flat ________
- Truss ________
- Sawtooth ________
- Steep ________

EXISTING ROOF:
- Cap ________
- Gravel ________
- Asphalt ________
- Tar ________
- Iron ________
- Shingles ________
- Asbestos ________
- Tile ________
- Fastener ________
- Slate ________
- Wood ________
- Skylights ________

FLASHINGS:
- Galvanized ________
- Copper ________
- Aluminum ________
- 3-C ________
- Irish ________
- Fabric ________
- Nail-on ________
- Valleys ________
- Gutters ________
- Coping ________
- Others ________

CONDITION OF ROOF Good ________ Fair ________ Bad ________
Is roof leaking? ________ Where? ________
Has it been coated? ________ Painted? ________
Material ________
Resurfaced? ________
Repaired? ________ Low spots? ________
Age? ________
Are walls coated? ________ Covered? ________
Material ________
Roof insulation? ________ Type ________
Thickness ________
Should roof be removed? ________
Spud-off ________
Nearest dump? ________
Permit ________ License ________

ACCESSIBILITY OF BLDG.
Street ________ Yard ________ Alley ________ Other ________
____

RECOMMENDATION OF WORK:
Roof ________
____
____
____
____
____
Walls ________
____
____
Flashings ________
____
REMARKS: ________
____
____
____
____
____
____
____
____
____

Inspection made by ________

UNIT E--ESTIMATING

TOPIC 2--PRINCIPLES OF ESTIMATING - Study Guide and Checkup

Study Guide

After you have studied the information in this topic and the assigned material, complete the following exercises:

1. List the three circumstances under which estimating is done:

a. ______________________________

b. ______________________________

c. ______________________________

2. List four things an estimator should know before he can estimate a job correctly:

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

3. List four safety precautions other than those mentioned in this topic that should be observed when estimating on site:

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

4. Name four things with which an estimator should be familiar before he can estimate a job:

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false:

1. The initial steps to take when learning to estimate roof jobs include the shortcut methods often used by experienced roofers. 1. T F

2. The apprentice should not concern himself too early with so-called "quality" methods because contractors rarely have a quality job to do. 2. T F

3. Previous job records can often be of major assistance to a roofer when estimating for a reroof job. 3. T F

4. For all practical purposes, there is no real limit to the number of reroofing operations on one roof before a spud-off job is necessary. 4. T F

5. Interpretation of both the architect's drawings and his specifications are necessary to prepare a proper estimate. 5. T F

6. The estimate sheet is essentially a form of communication. 6. T F

7. Competition and job costs must both be considered carefully when estimating a job for a bid. 7. T F

8. Specifications are not legal and binding on residential construction. 8. T F

9. A bonded roof is guaranteed by the manufacturer of the roofing material regardless of location, climate conditions, or method of application. 9. T F

10. Estimate forms, supplied by roofing material manufacturers, must be used by the contractors doing the roof work. 10. T F

UNIT E--ESTIMATING

TOPIC 3--MEASURING FLAT RECTANGULAR AREAS

This topic, "Measuring Flat Rectangular Areas," is planned to help you find answers to the following questions:

- Why is the ability to perform certain arithmetical calculations essential to the roofer?
- How many different formulas must be used to determine roof areas?
- How do the physical characteristics of each type of roof vary the formulas used for area computation?
- How can a complicated roof shape be broken down into one or more simple shapes for calculating purposes?

The ability to do arithmetical calculations accurately is essential to the roofer who wants to succeed in his occupation. Once the surface areas, lineal measure, and so forth have been determined for any job, the amount of material needed for the job may be calculated easily. Most roofing material manufacturers supply guides and charts showing what quantities of materials are required per square foot of roofing. With these aids, simple arithmetic--multiplication and division--is all that is needed to determine the quantities required for a job.

Formulas for Roofing Problems

This topic presents and explains the common formulas used on the job to solve measuring and calculating problems often faced by roofers.

Area of a Shed Roof Without Irregularities

The formula for finding the area of a shed roof that is square or rectangular without any irregularities is:

Area of shed roof = rake times width

In the case of the shed roof shown in Fig. E-2, the area would be computed thusly:

22 ft. × 20 ft. = 440 sq. ft., or 4 1/2 squares

(Note: The actual mathematical answer here is 4 4/10 squares, but the roofer should round this off to the nearest half when estimating small jobs. On big jobs, this fraction would be rounded off to the next whole number.)

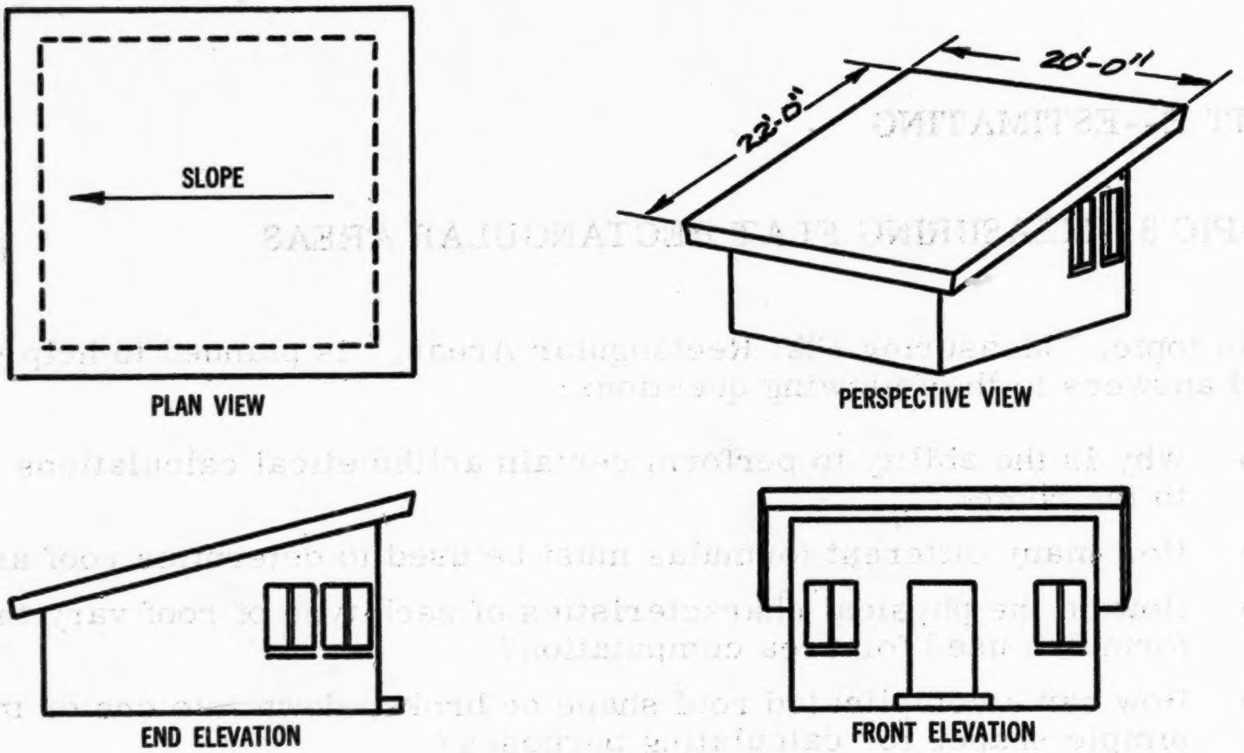


Fig. E-2. Four views of a shed roof

Area of a Gable Roof Without Irregularities

The formula for finding the area of a gable roof without irregularities is:

Area of gable roof = 2 times the slant width of roof (length of the rafter), times the length of the roof (ridge length).

In the case of the gable roof shown in Fig. E-3, the area would be computed thusly:

2 × 10 ft. × 20 ft. = 400 sq. ft. or 4 squares.

(NOTE: The roofer must be alert to the possibility that a gable roof may have a different slant width on one side than on the other. Also, the rakes may not always run parallel with the walls.)

Area of a Plain Hip Roof

The area of a plain hip roof is similar to the area of a gable roof of the same plan view dimensions and pitch. The formula for finding the area for a plain hip roof is:

Area of a hip roof = 2 times length of main slope times length of roof at eave.

In the case of the hip roof shown in Fig. E-4, the area would be computed thusly:

2 × 10 ft. × 30 ft. = 600 sq. ft., or 6 squares.

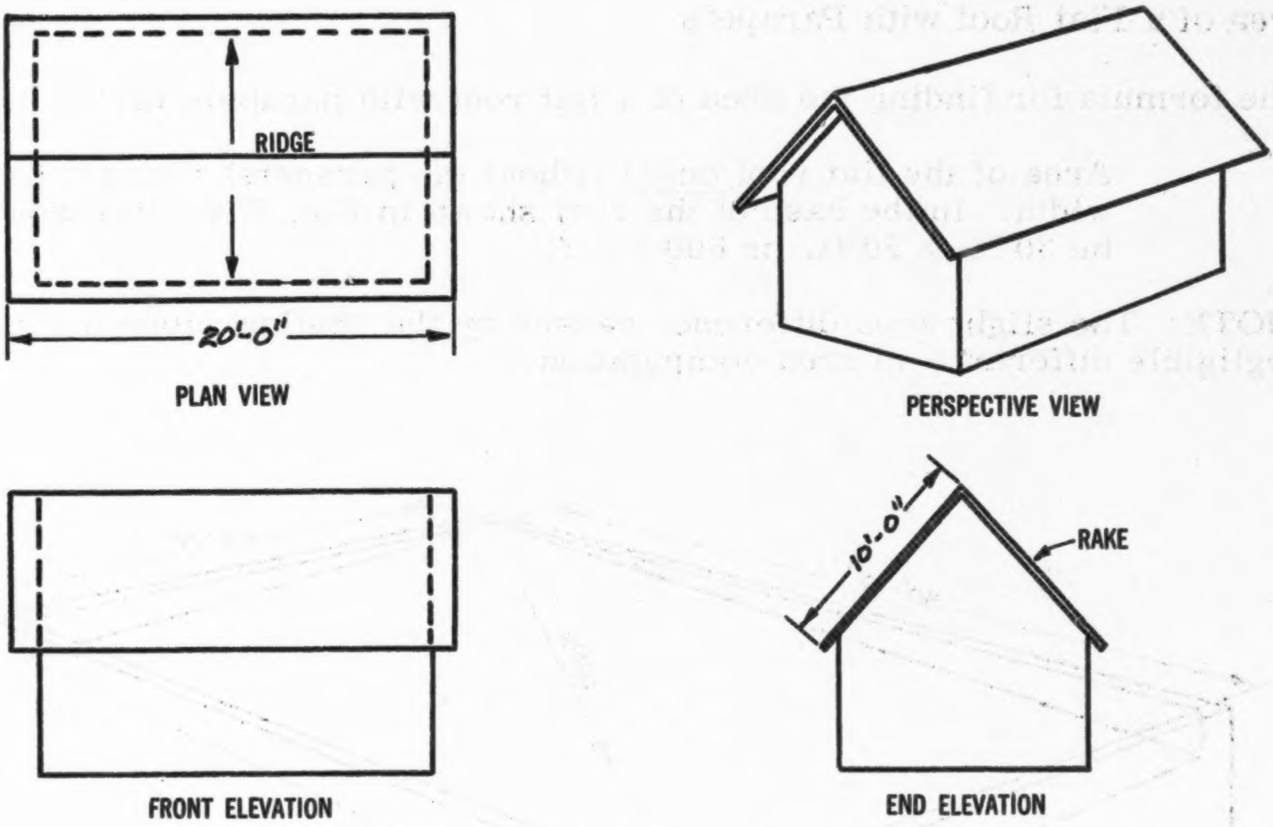

RIDGE
20'-0"
PLAN VIEW
PERSPECTIVE VIEW
10'-0"
RAKE
FRONT ELEVATION
END ELEVATION

Fig. E-3. Four views of a gable roof

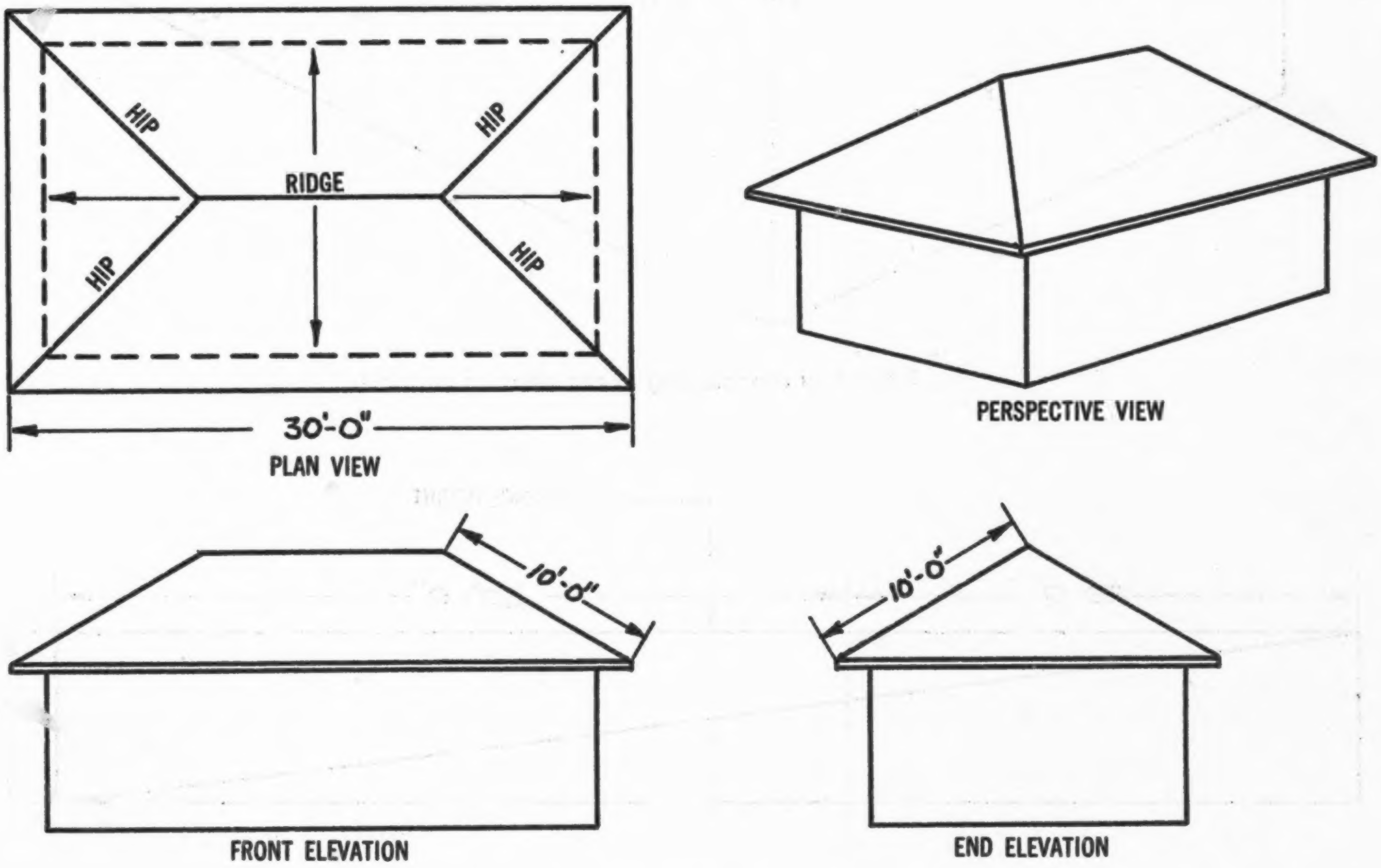

HIP
HIP
RIDGE
HIP
HIP
30'-0"
PLAN VIEW
PERSPECTIVE VIEW
10'-0"
10'-0"
FRONT ELEVATION
END ELEVATION

Fig. E-4. Four views of a hip roof

Area of a Flat Roof with Parapets

The formula for finding the area of a flat roof with parapets is:

> Area of the flat roof only (without the parapets) = length times width. In the case of the roof shown in Fig. E-5, this would be 30 ft. × 20 ft. or 600 sq. ft.

(NOTE: The slight area difference caused by the shallow slope makes a negligible difference in area computation.)

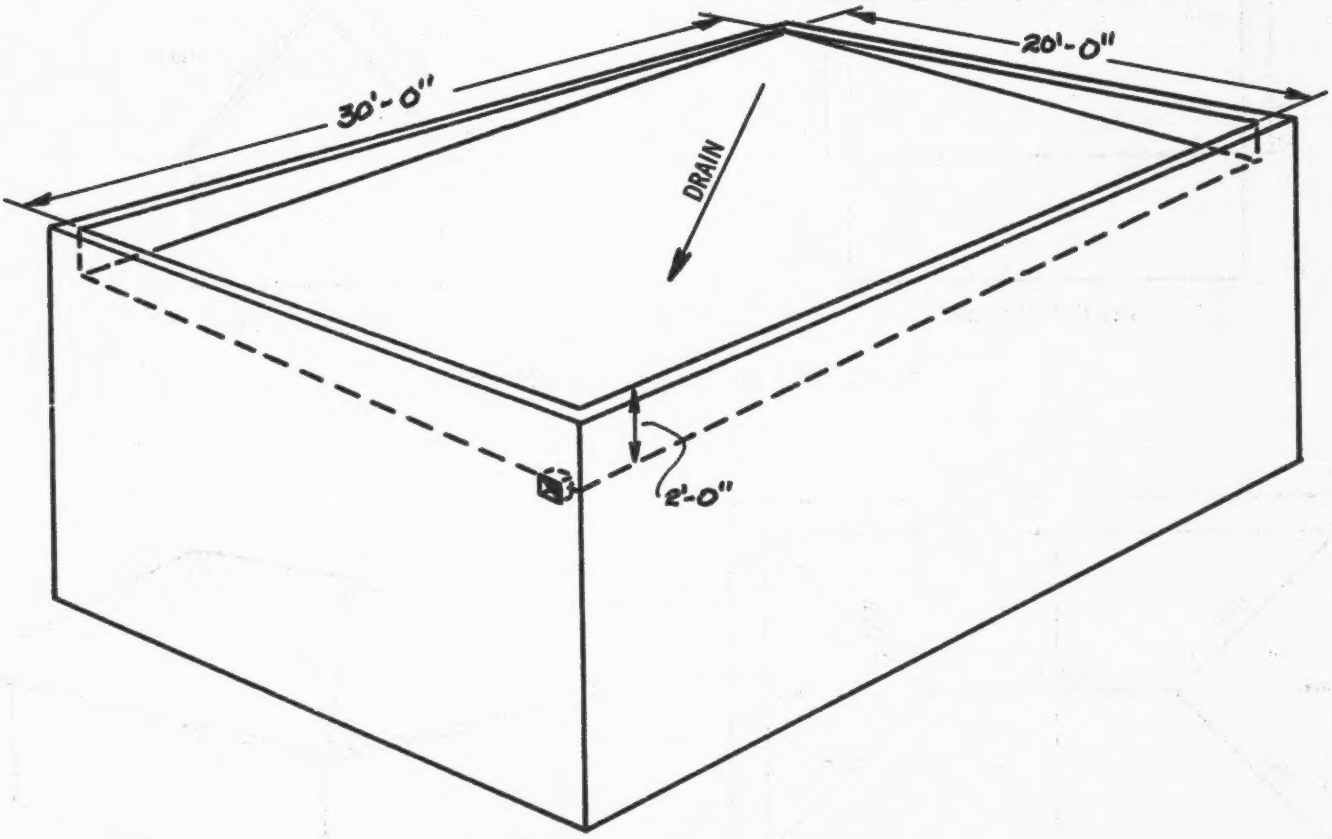


Fig. E-5. Flat roof sloping to top edge of parapet

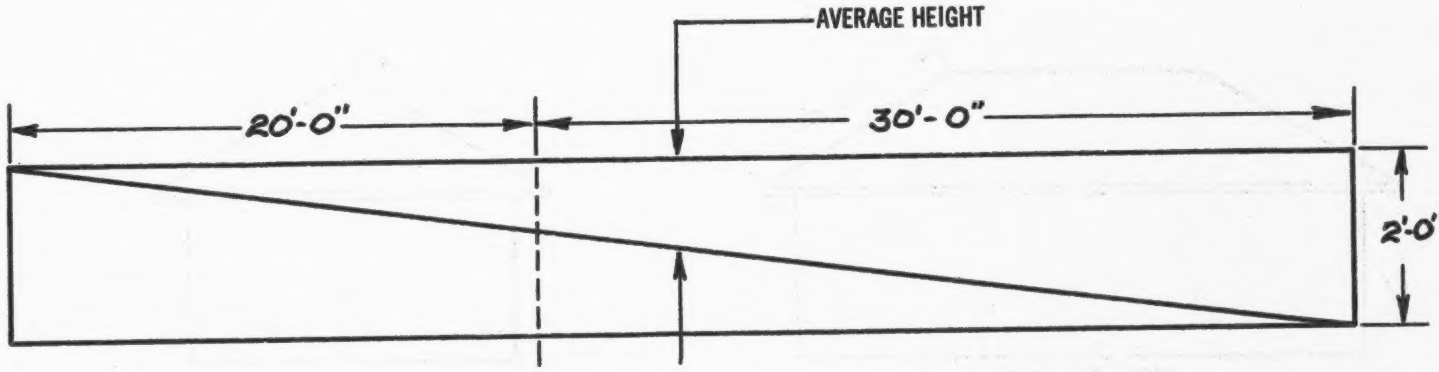


Fig. E-6. Stretchout of vertical surfaces of parapet

The vertical area on the inside surfaces of the parapets must now be added. This area may be computed in several ways. One way may be described thusly:

If the roof tapers up to the top of the parapet at its high point (as shown in Fig. E-5), the vertical area of the parapet may be thought of as two right triangles as shown in Fig. E-6.

The solution may be arrived at in two steps:

1. 50 ft. × 2 ft. × 1/2 = 50 sq. ft. (area of one triangle)
2. 50 sq. ft. x 2 = 100 sq. ft. (vertical area of parapet)

If, however, the highest point of the roof is lower than the top of the parapet, the vertical surfaces of the parapet may be thought of as an elongated rectangle. (See Figs. E-7 and E-8.)

The solution in this case may be arrived at thusly:

3 ft. × 50 ft. = 150 sq. ft., or 1 1/2 squares.

(NOTE: When actually estimating at the job site, this procedure is greatly simplified by simply adding the average height of the parapet to the roof dimensions. The average height in Fig. E-8 is found at about 27 ft., while in Fig. E-6 it is found at 25 ft.)

Area of a "T" Roof--Gable or Hip

The area of a "T" roof may be determined in the following manner (Fig. E-9):

1. Calculate the area of the main roof, disregarding the "T". (Use the method previously described for a simple gable roof.)
2. Add to this area the square feet of the "T". (Do not include the shaded area, since this was included in the calculations for the main roof.)

Calculate the areas as follows:

24 ft. × 25 ft. = 600 sq. ft.

5 ft. × 16 ft. = 80 sq. ft.

Total area = 680 sq. ft., or 4 squares

(NOTE: When figuring a hip roof, the extra ridges and hips should be included.)

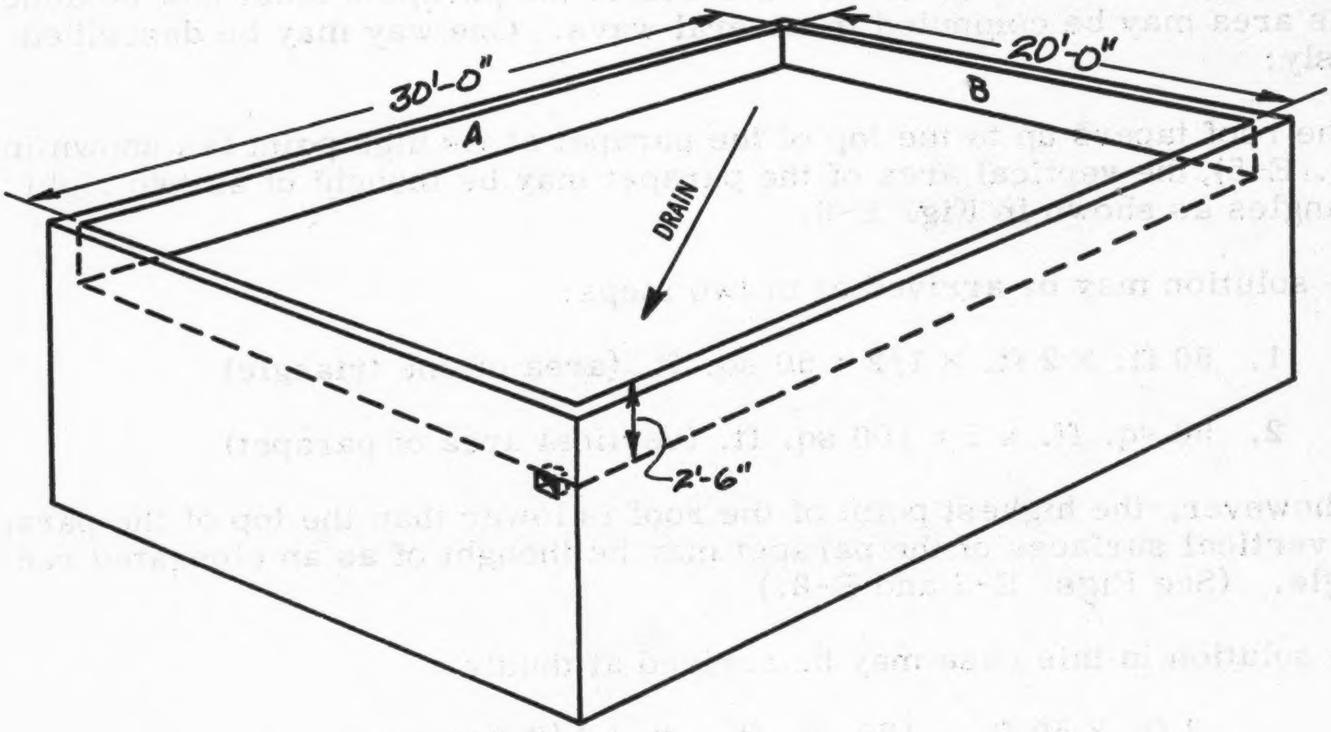

30'-0"
20'-0"
A
B
DRAIN
2'-6"

Fig. E-7. Flat roof sloping to within 6 in. of top of parapet

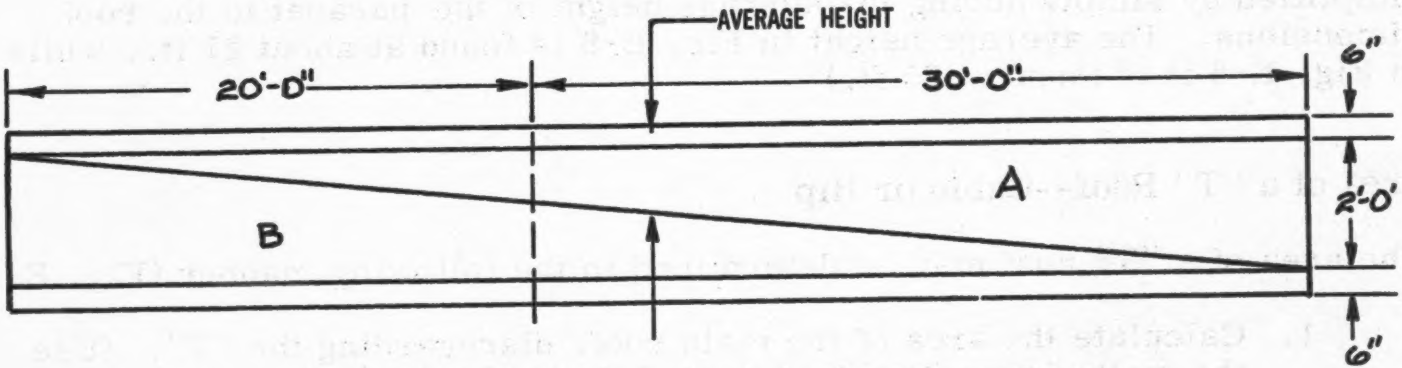

AVERAGE HEIGHT
20'-0"
30'-0"
6"
A
B
2'-0"
6"

Fig. E-8. Stretchout of vertical surfaces of parapet

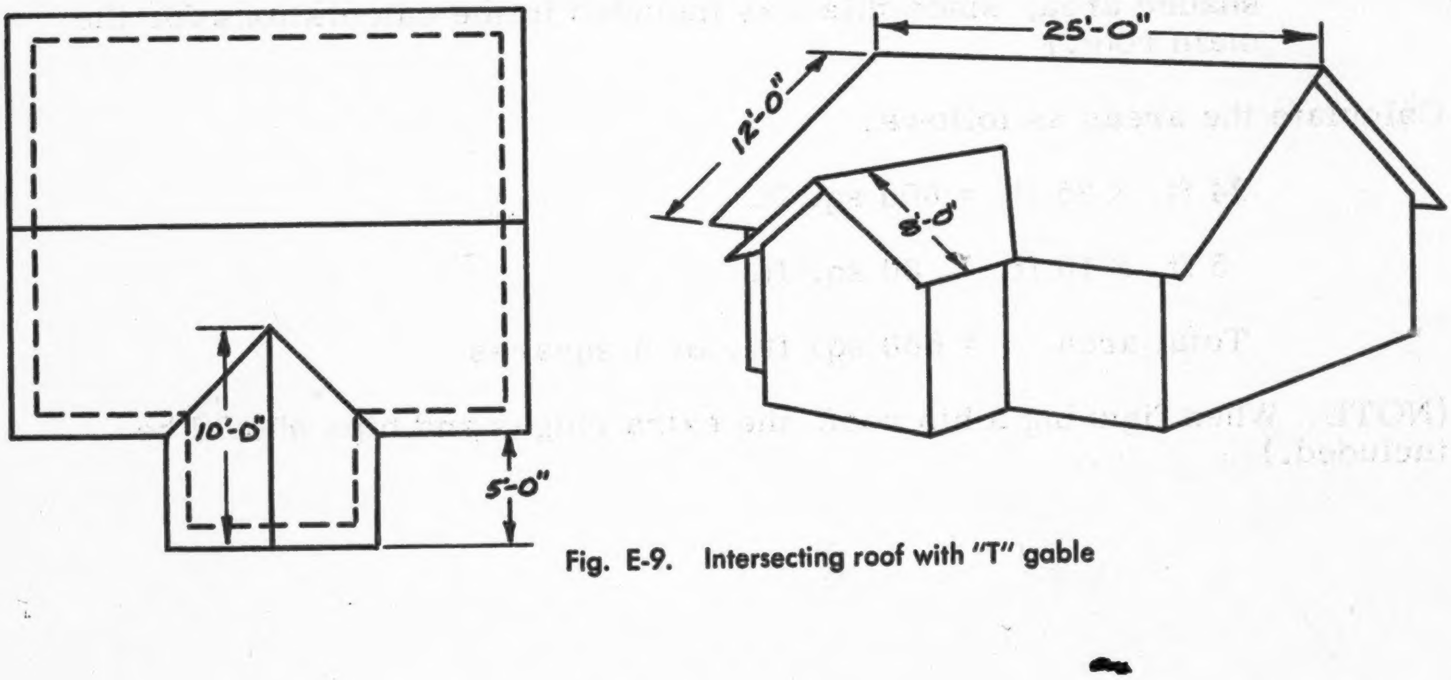

10'-0"
5'-0"
25'-0"
12'-0"
8'-0"

Fig. E-9. Intersecting roof with "T" gable

Area of an "L" Roof--Hip or Gable

The area of an "L" roof = total length of two ridges times the length of the rafter times 2.

In the case of the "L" roof shown in Fig. E-10, the total area may be determined in three steps:

1. 20 ft. + 30 ft. = 50 ft.
2. 10 ft. × 2 ft. = 20 ft.
3. 50 ft. × 20 ft. = 1,000 sq. ft., or 10 squares

NOTE: It is sometimes easier to take measurements at the rake and eave to arrive at the same conclusion. In this fashion only two rectangles need be considered:

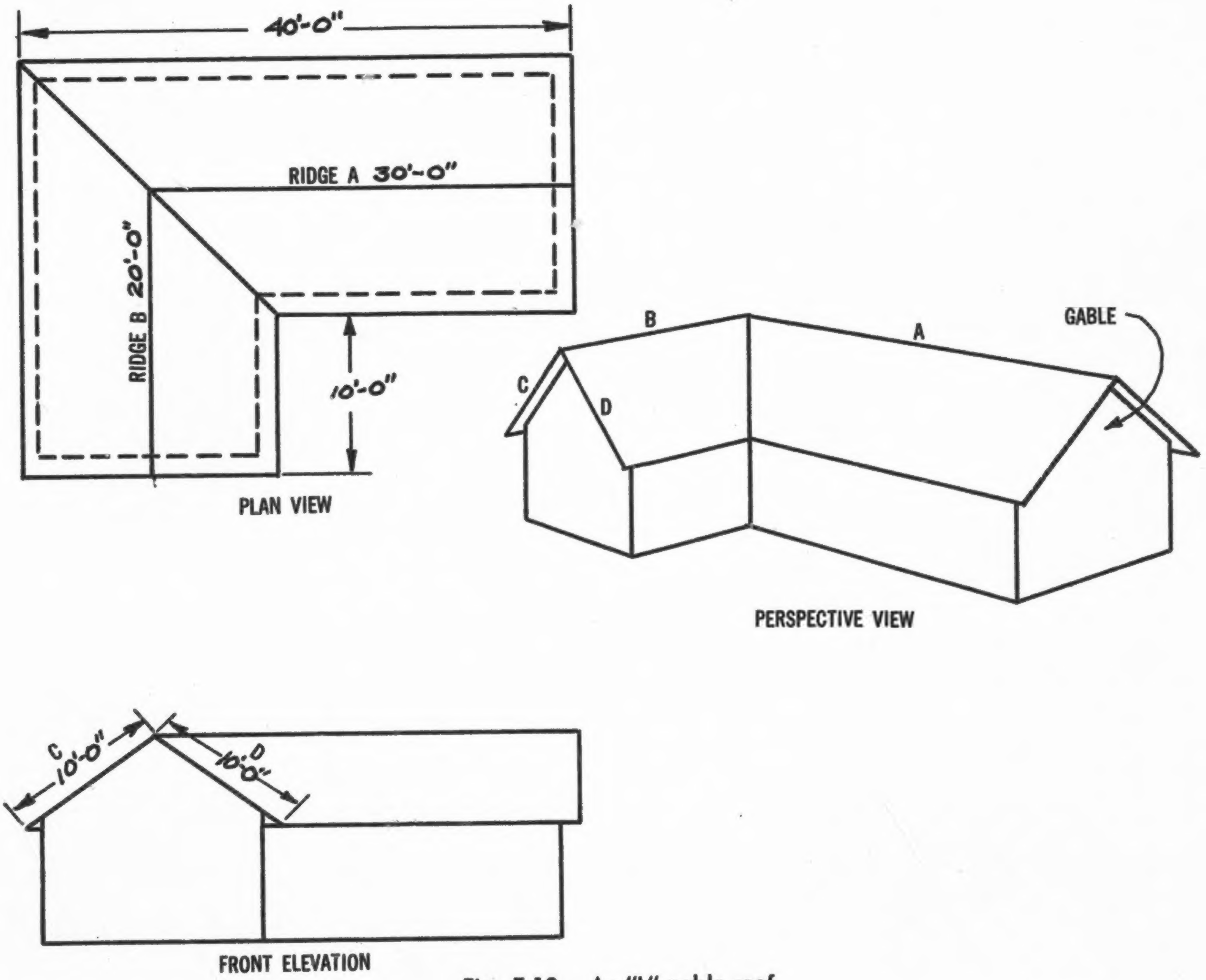

40'-0"
RIDGE A 30'-0"
RIDGE B 20'-0"
10'-0"
PLAN VIEW
B
A
GABLE
C
D
PERSPECTIVE VIEW
C
10'-0"
D
10'-0"
FRONT ELEVATION

Fig. E-10. An "L" gable roof

1. 40 ft. × 20 ft. = 800 sq. ft.
2. 10 ft. × 20 ft. = 200 sq. ft.
3. 800 sq. ft. + 200 sq. ft. = 1,000 sq. ft., or 10 squares

Study Assignment

1. G. M. Hobbs, J. McKinney, and J. R. Dalzell, Practical Mathematics, Section 12, pp. 437-52.
2. J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products, pp. 91-97.

UNIT E--ESTIMATING

TOPIC 3--MEASURING FLAT RECTANGULAR AREAS - Study Guide and Checkup

Study Guide

After you have studied the material in this topic and the assigned material, complete the following exercises:

Give the formula for finding the following areas:

1. A gable roof 1. ______________________________
2. "T" roof 2. ______________________________
3. A shed roof 3. ______________________________
4. A parapet 4. ______________________________
5. A hip roof 5. ______________________________
6. An "L" roof 6. ______________________________

Checkup

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. To find the area of a "T" gable roof, multiply the length of the main roof rake by two, and then multiply this figure by the length of the eave. Next, multiply the rake length of the "T" by two, and multiply this figure by the length of the eave. Then add the two results. 1. T F

2. To find the area of an all hip "T" gable, add 10 percent waste to the area of the same size gable roof. 2. T F

3. When estimating a flat roof with parapets, no consideration need be given the parapet areas. 3. T F

4. The rake length of a building is always the same as the rafter length. 4. T F

5. The pitch of a roof has no bearing on the area. 5. T F

6. As a practical matter, parapet areas can be computed by using average heights. 6. T F

7. The area of an "L" roof can be estimated by considering the main roof and the "L" as two separate rectangles and adding these areas together. 7. T F

8. A perspective view of a building always shows the entire roof of a hip roof. 8. T F

9. In the case of a flat roof with a slight slope, adjustment must be made for the slope in the area computations. 9. T F

10. Once the total area of a roof is determined in square feet, that figure is divided by 100, then raised to the nearest whole number, to arrive at the number of squares required. 10. T F

UNIT E--ESTIMATING

TOPIC 4--MEASURING CURVED AND IRREGULAR SURFACES

This topic, "Measuring Curved and Irregular Surfaces," is planned to help you find answers to the following questions:

- What method is used to determine the area of a triangular roof?
- How can the area of a circular roof be broken down into square feet?
- What are the best methods of determining the area of cylindrical tanks and conical roofs?
- How does the area of a sphere relate to a dome roof?
- What is the main difference between a barrel roof and a bullnose roof?
- Why should the roofer estimate off the plan view of a hyperbolic roof?
- In what way can irregularly-shaped roofs be broken down into calculable areas?

The most complicated roof measurements to make are those dealing with curved and irregular surfaces and edges. This process involves only basic arithmetic with simple formulas. Even the most irregular surface areas, such as hyperbolic and kidney-shaped roofs, are simple to calculate when broken down into smaller areas of more conventional shape.

Methods of Calculating Curved Surfaces

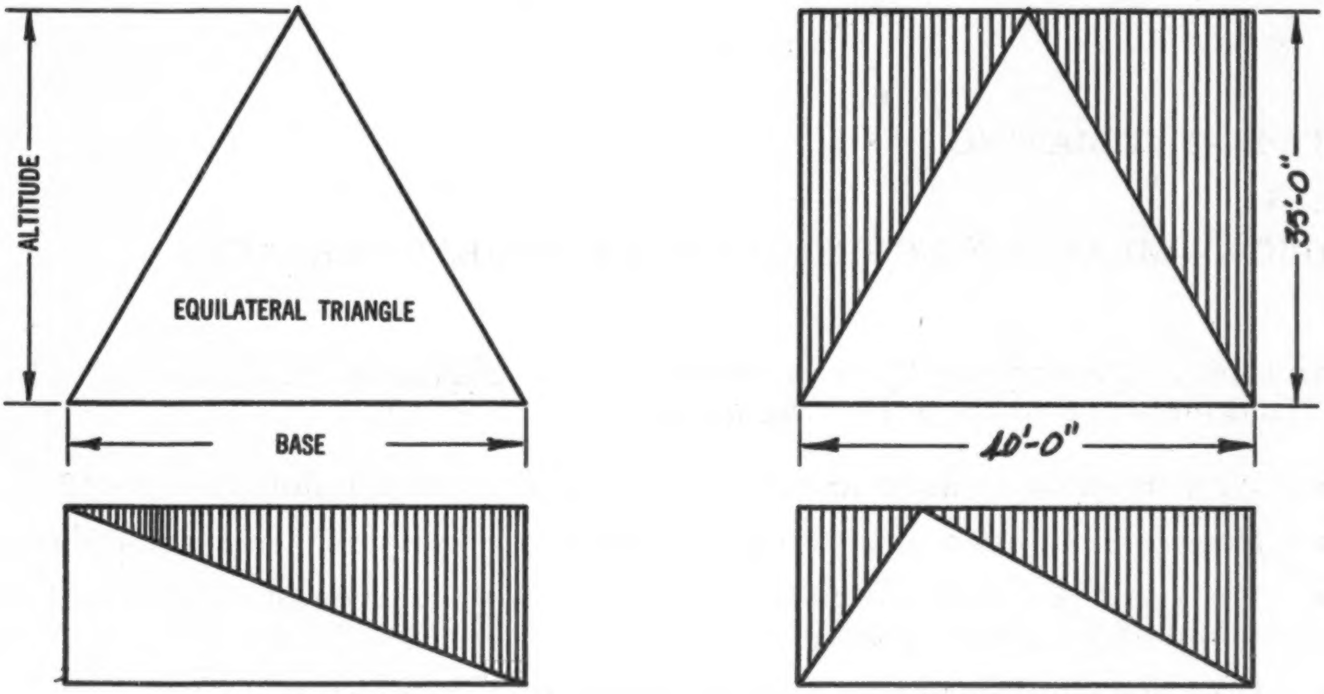
Once the process of calculating these areas is understood, shortcuts and tables can be used with confidence. The following methods and formulas are essential for figuring areas of curved surfaces:

Area of a Triangular Dead Flat Roof

A triangle with three equal sides is called equilateral. A triangle with one 90-degree corner is a right triangle. When a triangle has two equal sides, it is an isosceles. Any other triangle is considered a scalene (Fig. E-11).

The formula for figuring the area of a triangle may be stated thusly:

$$\text{Area} = \frac{\text{Base} \times \text{Altitude}}{2}$$

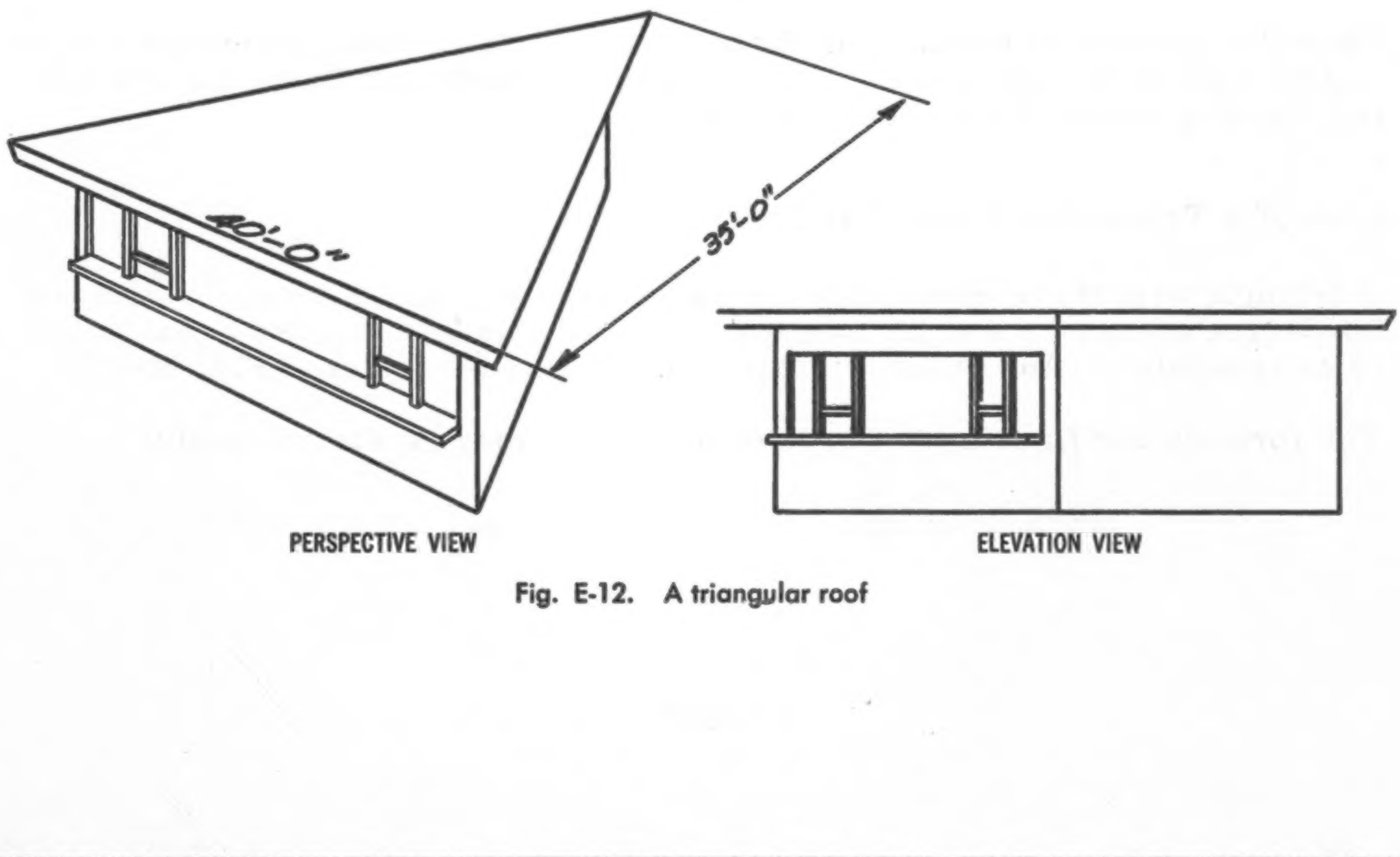


RIGHT TRIANGLE

SCALENE TRIANGLE

Fig. E-11. Types of triangles

In the case of the roof pictured in Fig. E-12, the area would equal 40 ft. (the base) times 35 ft. (the altitude), divided by 2, or 700 sq. ft. (7 squares of roofing). Dividing by two is the same as dividing in half, and it will be noted in Fig. E-11 that the shaded areas are equal to one half the total area of the rectangle, therefore equal to the unshaded areas. The shaded areas, reversed and placed together, will form a triangle identical to the unshaded triangle. This explains a shortcut to the formula given: divide either the base or the altitude in half before multiplying, and the proper answer is secured without having to divide by two.



PERSPECTIVE VIEW

ELEVATION VIEW

Fig. E-12. A triangular roof

Area of a Circular Roof

The formula for determining the area of a circle is Area = πr^2, where π equals 3.1416 (the Greek letter pi, a constant, meaning that the diameter of any circle will fit around the circumference 3.1416 times; this is usually shortened to 3.14 for calculating roof areas); r equals the radius of the circle (one-half the diameter); and the "2" means squared (multiplied by itself). Thus, in the case of the roof shown in Fig. E-13, one-half the diameter of 100 ft. is 50 ft. This figure squared is 2,500. Multiplying this by 3.14, the result is 7,850, expressed in square feet. This roof will require 79 squares of roofing.

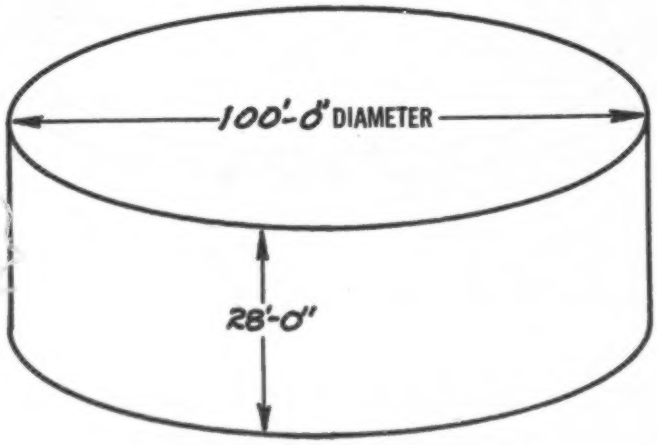


Fig. E-13. Cylindrical water tank

Area of the Walls of a Cylindrical Tank

The formula for determining the area of the walls of a cylindrical tank is Area = $\pi (d \times h)$, where "d" is the diameter of the tank and "h" the height (Fig. E-13). Thus, $3.14 \times 100 \times 28 = 8,792$, expressed in square feet. The walls in question will therefore require 88 squares of roofing.

Area of a Conical Roof

The surface area of a conical roof may be found by the formula: one-half slant height times circumference of the base equals the surface area.

In the case of the conical roof shown in Fig. E-14, the following steps should be taken:

1. $1/2 \times 10 = 5$
2. $5 \times 31.5 = 157.5$, expressed in square feet

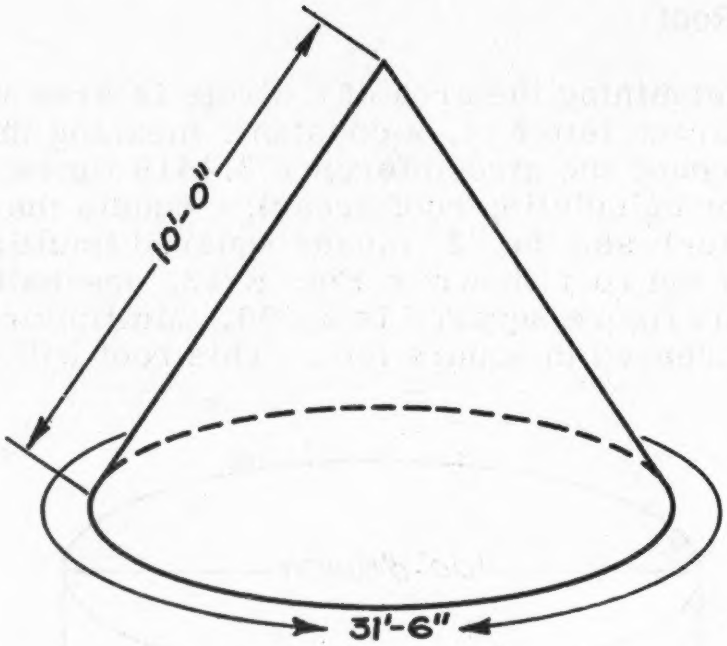


Fig. E-14. Conical roof

Area of a Dome Roof

The area of a semispherical dome roof is equal to one-half the area of a sphere with the same diameter. Dome roofs are becoming quite common, and the roofer should know the process for finding the area of a sphere and how to use this in his calculations.

The dome roof shown in Fig. E-15 has a diameter of 100 ft. and a height of 50 ft. Since the height is exactly half of the diameter, it is equal to the radius. The area of a sphere is equal to $4\pi r^2$, and the area of a semispherical dome is one-half of that.

The area of the dome roof shown in Fig. E-15 may be determined as follows:

1. $4 \times 3.14 \times 50^2 = 31,400$
2. $31,400 \div 2 = 15,700$, the area of the roof in square feet, requiring 157 squares of roofing

Area of a Barrel Roof

The area of a barrel roof (shown in Fig. E-16) may be computed as a curved rectangle by adding 1/7 (or 14 percent) of the span to the span length. This procedure is not wholly accurate, nor will it apply equally well in all cases, but it is used successfully as a rule of thumb by many roofers when estimating for a barrel roof.

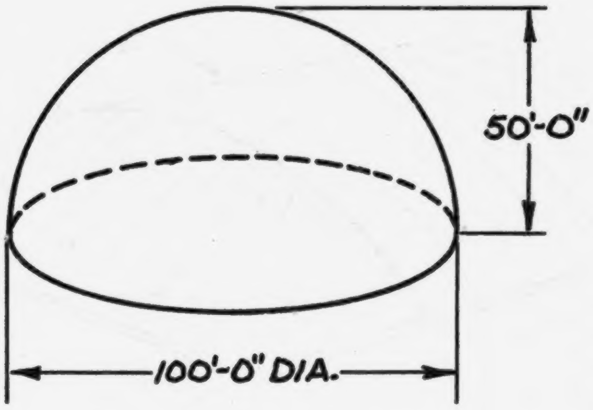


Fig. E-15. Dome roof

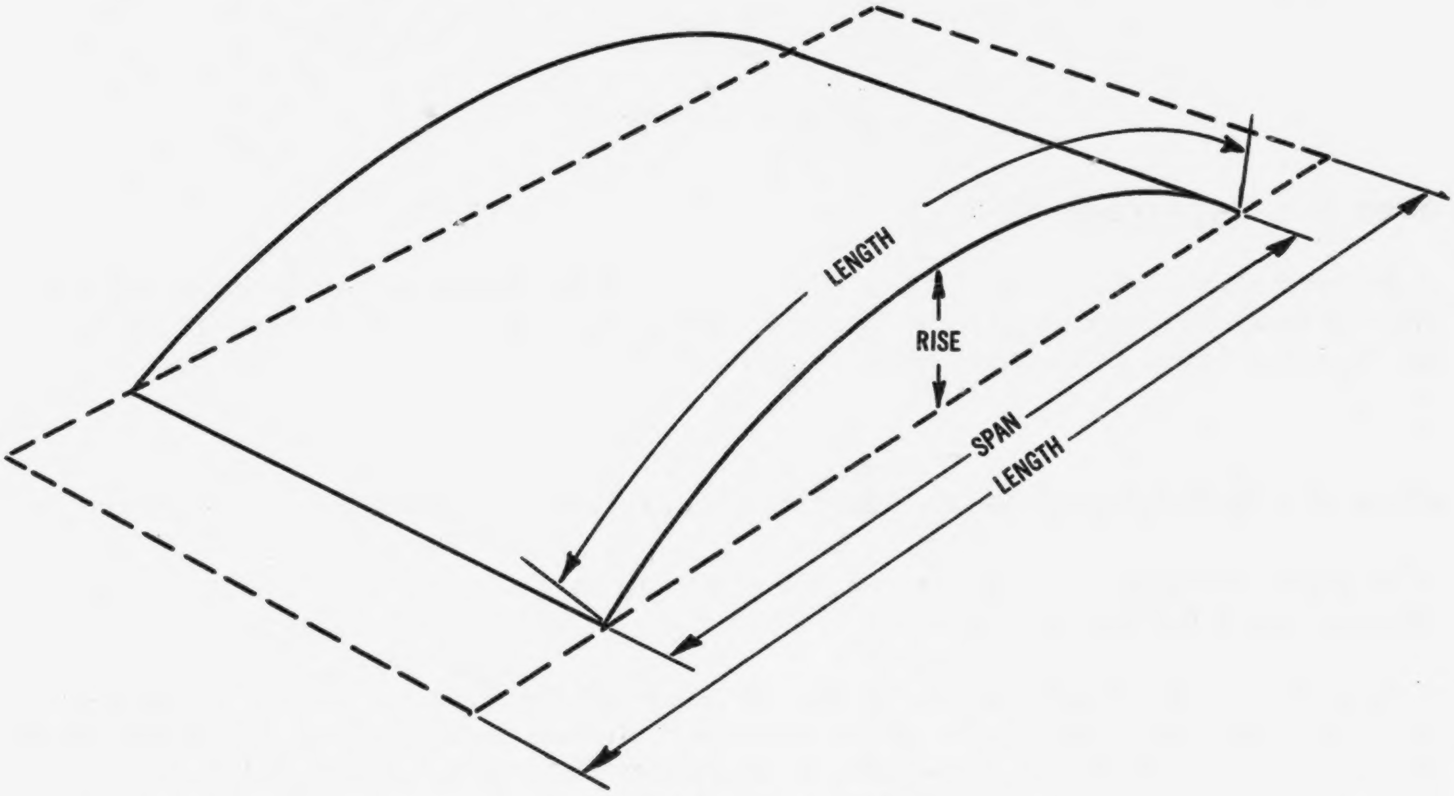


Fig. E-16. Barrel roof

Area of a Bullnose Roof

The area of a bullnose roof is figured just as though the bullnose did not exist and the barrel roof extended to the end of the building (Fig. E-17). Although there is a slight reduction in area because of the bullnose, it is negligible and can be disregarded for estimating purposes. (Section A of the bullnose roof in Fig. E-17 is the barrel portion of the roof.)

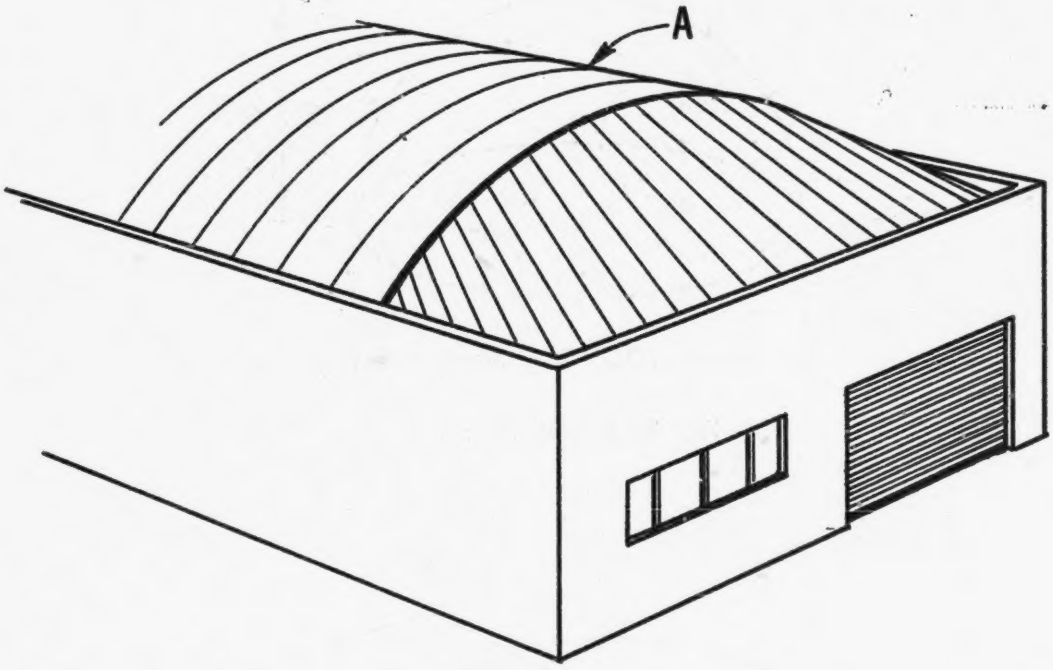


Fig. E-17. Bullnose roof

Area of a Hyperbolic Roof

A hyperbolic roof, looked at in plan view, often turns out to be nothing more than a modified rectangle or diamond (Fig. E-18). In this case, it should be figured from this standpoint, multiplying A times B and dividing by 2.

Area of a Kidney-shaped or Other Irregularly Curved Flat Surface

The most accurate method of calculating the area of an especially irregular shape, such as that pictured in Fig. E-19, is with the grid system.

Grids should be drawn to the scale of the architectural drawing being used. Transparent grid sheets are available which can be laid over the drawing for this purpose. If the scale of the drawing in Fig. E-19 were 1/16" = 1'-0", then each 1/4" would equal 16 sq. ft.

For computation of an area using grids the following procedure should be used:

1. Count the number of whole squares within the outline.
2. Count the number of half squares within the outline and divide by two.
3. Count the number of third squares within the outline and divide by three.
4. Count the number of triangles within the outline and divide by two.
5. Add all of these totals together and multiply by 16. The final answer will be the area of the roof expressed in square feet.

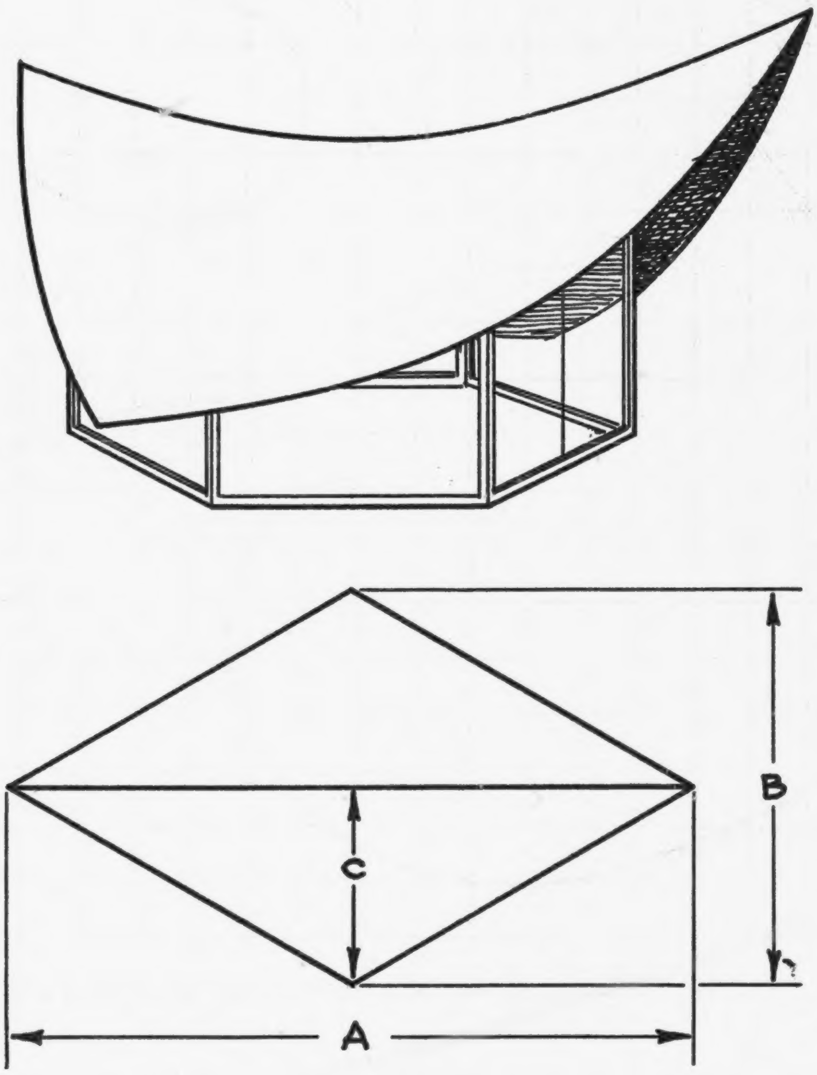


Fig. E-18. Hyperbolic roof

A faster but less accurate method to calculate the area of an irregular surface is to break it down into calculable shapes -- triangles, rectangles, circles, and so forth. Such a surface is shown in the perspective view in Fig. E-20. A suggested division of this surface is pictured in Fig. E-21.

In the breakdown in Fig. E-21, the areas A, B, C, and E are calculated and totalled. Then areas D, F, and G are calculated and subtracted from the first total. The result is the area of the surface.

Lineal Measurements

Lineal measurement is used in the roofing trade for determining the straight footage of edgings, hips, ridges, starter strip flashings, gutters, and so forth. It does not involve area in the sense of square footage. When estimating for amounts of material, the roofer must not only figure the exact lineal measurement (in linear feet) but also make allowance for laps, corners, and waste. These considerations increase the total amount of material required.

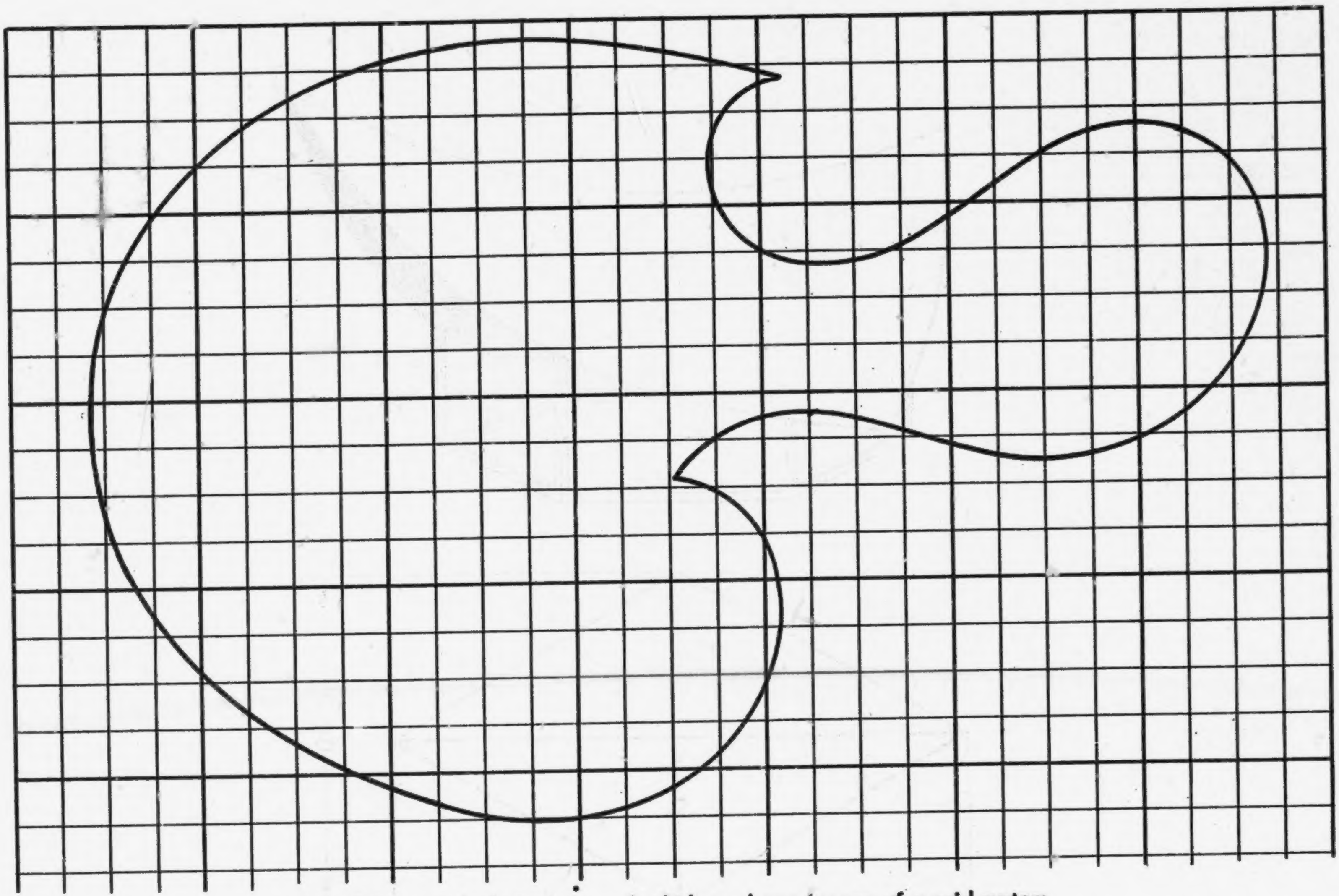


Fig. E-19. Calculating area of a kidney shape by use of a grid system

The perimeter of a roof is the distance around the roof (or outer boundary) in linear feet, regardless of the shape of the roof -- square, triangular, round, or whatever. Such a measurement does not, of course, reflect the total amount of material needed because other parts of the same roof, requiring the same material, may have to be considered.

Volume

Volume calculations may be necessary in an estimate when large quantities of "low melt" and fibrated plastic are required to fill a number of pitchpan flashings. Frequently, large factory roofs are found to have hundreds of such flashings. If, for example, each one takes one pint of material and 300 must be filled, total volume then becomes an important item.

The following formula may be used in determining the volume of material required:

Volume of each cubicle = length × width × height

Volume of each cylinder = pi × diameter × height

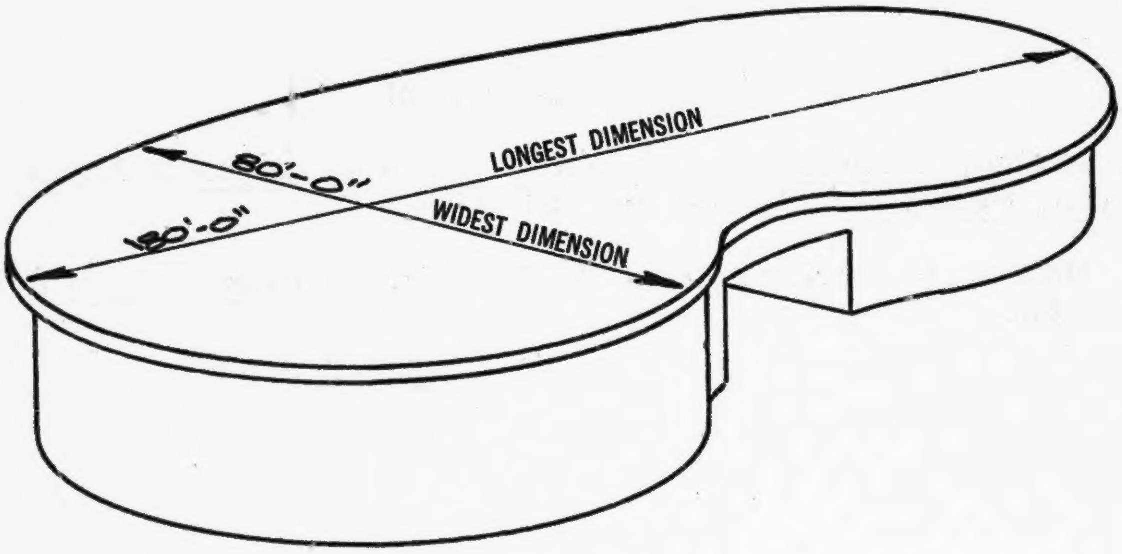

80'-0"
LONGEST DIMENSION
180'-0"
WIDEST DIMENSION

Fig. E-20. Kidney-shaped roof

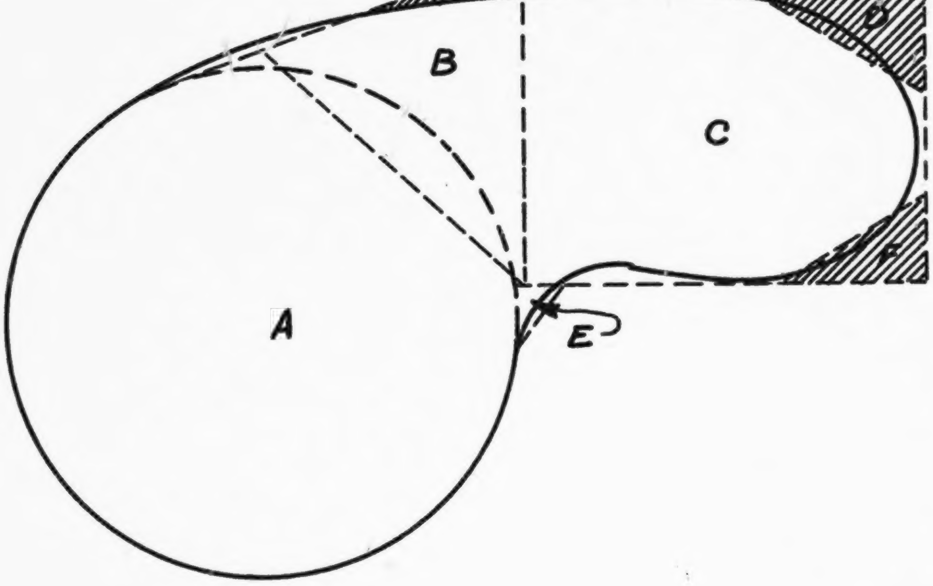


Fig. E-21. Irregular shape broken down into calculable areas

The container of material will show the weight of the contents in pints, quarts, or gallons transposed into cubic measure. With these figures available, the roofer can easily determine the amount needed for any job.

Study Assignment

1. J. L. Strahan, Manufacture, Selection and Application of Asphalt Roofing and Siding Products. Review pp. 191-97.
2. G. M. Hobbs, J. McKinney, and J. R. Dalzell, Practical Mathematics, pp. 452-86.

UNIT E--ESTIMATING

TOPIC 4--MEASURING CURVED AND IRREGULAR SURFACES

Study Guide

After you have studied the material in this topic and the assigned material, complete the following exercises:

1. Draw, in the spaces below, (A) an isosceles triangle, (B) a right triangle, and (C) a scalene triangle.

A B C

2. What is the formula for calculating the area of a triangle?

Area =

3. What is the formula for calculating the area of a circle?

Area =

4. What is the formula for calculating the area of a sphere?

Area =

5. What is the formula for calculating the circumference of a circle?

Circumference =

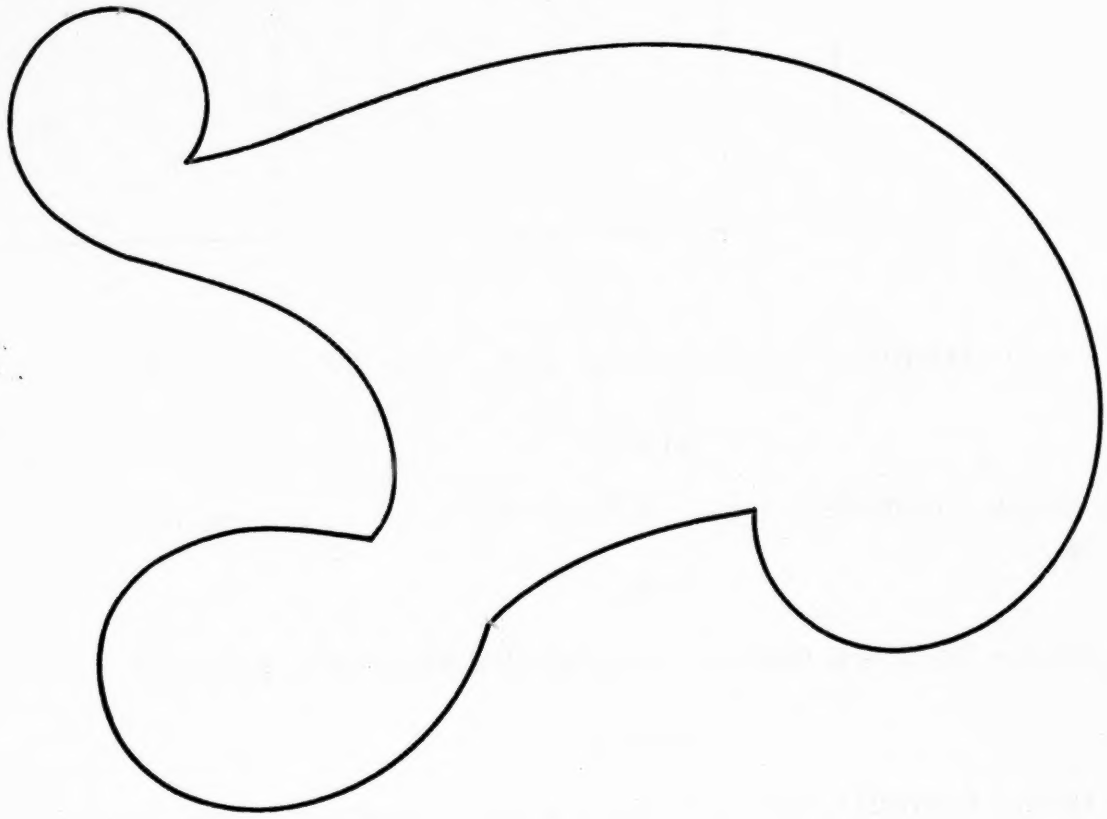
6. What is the formula for calculating the area of a cone?

Area =

7. What is the procedure for calculating the area of a bullnose roof?

8. What is the procedure for calculating the area of a hyperbolic roof?

9. Show how to divide the following irregular shape into calculable areas, and show how to find the area of the shape using the grid system. The scale may be assumed to be 1/16" = 1' 0".



10. What is the formula for determining the volume of a cylinder?

Volume =

unit

f

Exercises in Estimating

TOPIC 1--BASIC INFORMATION

This unit, "Exercises in Estimating," consists of a series of exercises which do not have corresponding tests in the testbook. These exercises should be graded by the instructor for accuracy, clarity, readability, and the correct application of knowledge gained through the study of this course. To perform these exercises satisfactorily, the apprentice will be required to reason out complete roofing problems, thereby testing his understanding of estimating procedures.

Practice in Lineal Measurement

It is suggested that the instructor secure surplus architectural drawings and specifications and that he use the Blueprint Reading and Examination Kit of the American Technical Society. The instructor may devise special drawings which will serve the same purpose--that of offering practice in area and linear measurement and in the calculation of material quantities.

Suggested Estimate Form

Each exercise or group of exercises includes some basic instructions for the specific estimating job being considered. A suggested estimate form appears on the following four pages and may be used as a sample to make a sufficient number of forms for use in the classroom. This form is also included in the back of the testbook and may be removed for reproducing purposes. The instructor may, however, supply forms of his own choosing. Most roofing estimate forms call for the same basic information; the only differences involved are in the scope or organization of the form. The forms provided herein are designed to include the best characteristics of several different forms used throughout the industry.

Some exercises call for the use of a specification which must be selected from a manufacturer's specification manual. (A custom specification may be developed by the instructor.)

As an answer key for each exercise, the instructor will prepare a complete estimate as it should be done, except for labor, overhead, and material costs.

Roofing practices differ from region to region, and each instructor's answer will reflect this. In view of these differences the instructor should exercise a certain flexibility in checking the student's work for accuracy.

Estimating Exercise No. _____

Roofing Estimate ____________________ Job No. ____________ Date __________
Name of Building ____ Phone __________
Job Location ____
Owner _______________________ Address ________________ Phone __________
Architect ____ Phone __________
Contractor ____ Phone __________

JOB MEASUREMENTS

1	x	lin. ft.	sq. ft.
2	x		
3	x		
4	x		
5	x		
6	x		
7	x		

8	x	lin. ft.	sq. ft.
9	x		
10	x		
11	x		
12	x		
13	x		
14	x		

JOB SKETCH (Use proper scale)

Estimating Exercise No. ____

Roofing Estimate ______________ Job No. ____________ Date ________
Name of Building ______________________________ Phone ________
Job Location ____
Owner ______________ Address ____________ Phone ________
Architect ______________________________ Phone ________
Contractor ______________________________ Phone ________

Estimator's Check List

☐ 1. Main roof
☐ 2. Base flashings
☐ 3. Counter flashings (plastic)
☐ 4. Cap flashings (plastic)
☐ 5. Counter flashings (metal)
☐ 6. Cap flashings (metal)
☐ 7. Valleys
☐ 8. Insulation
☐ 9. Gutters
☐ 10. Leaderpipes
☐ 11. Masonry walls
☐ 12. Skylights
☐ 13. Monitors
☐ 14. Dormers
☐ 15. Chimneys
☐ 16. Pipe and other metal flashings
☐ 17. Outlets
☐ 18. Roof decking
☐ 19. Debris
☐ 20. Use of roof
☐ 21. Shingles
☐ 22. Hip and ridge
☐ 23. Other

RECOMMENDATIONS: (Place item number below and suggest treatment)

Estimating Exercise No. ____

Roofing Estimate ____________ Job No. ____________ Date ____________
Name of Building ____________ Phone ____________
Job Location ____________
Owner ____________ Address ____________ Phone ____________
Architect ____________ Phone ____________
Contractor ____________ Phone ____________

MATERIALS

Sale Price ____________
Solicitor ____________
Labor - Material ____________
Salesman ____________
Overhead ____________
Profit ____________

ESTIMATOR'S MATERIAL

CHECK LIST

Felts
- ☐ 7# sheathing
- ☐ 20# rosin size
- ☐ 30# rosin size
- ☐ 15# asphalt felt
- ☐ 30# asphalt felt
- ☐ 40# smooth roofing
- ☐ 45# smooth roofing
- ☐ 55# smooth roofing
- ☐ 65# smooth roofing
- ☐ 75# smooth roofing
- ☐ 15# asbestos felt
- ☐ 30# asbestos felt
- ☐ 45# asbestos felt
- ☐ 55# asbestos felt
- ☐ 15# tar felt
- ☐ 30# tar felt
- ☐ 8# fiberglas plysheet
- ☐ Super plysheet
- ☐ Vapor barriers

Capsheets
- ☐ 105# mineral surfaced capsheet
- ☐ 90# mineral surfaced capsheet
- ☐ 90# asbestos mineral capsheet
- ☐ 72# fiberglas mineral surfaced cap
- ☐ 35# split sheet mineral surfaced capsheet

Plastic and Asphalt Pitch
- ☐ Asphalt (steep)
- ☐ Asphalt (low slope)
- ☐ Coal tar pitch
- ☐ Plastic cements
- ☐ Caulking compounds

Fasteners
- ☐ Tin caps
- ☐ Cap nails
- ☐ Roofing nails (other)
- ☐ Concrete nails

Insulations
- ☐ Insulation - type thickness
- ☐ Insulation thickness cant strip
- ☐ Insulation thickness tapered edge strip
- ☐ Insulation thickness clips
- ☐ Insulation thickness adhesive

Fabrics
- ☐ Pitch saturated fabric
- ☐ Asphalt saturated fabric
- ☐ Fiberglas fabric
- ☐ 16# fiberglas combination
- ☐ Flaxfelt

Flashings and Hardware
- ☐ Edge metal
- ☐ Counter flashings (metal)
- ☐ Roof drains and strainers
- ☐ Base flashings
- ☐ 5 course or 3 course flashings
- ☐ Plastic type flashings (neoprene)
- ☐ Pitch pockets
- ☐ Splash pans

Damp and Waterproofing

Coatings
- ☐ Aggregate (kind)
- ☐ Primer, asphalt
- ☐ Asphalt roofcoatings
- ☐ Asphalt foundation coatings
- ☐ Asphalt emulsions
- ☐ Aluminum coatings
- ☐ White coatings

Shingles
- ☐ Asphalt shingles (kind)
- ☐ Hip and ridge units
- ☐ Starter rolls (size)
- ☐ Valley rolls

Miscellaneous
- ☐ Cotton mops
- ☐ Glass mops
- ☐ Kerosene
- ☐ L.P.G. gas
- ☐ Guarantee
- ☐ Schedule of Roofing Work
- ☐ Access to buildings

UNIT F--EXERCISES IN ESTIMATING

TOPIC 2--COATINGS

Protective coatings serve three main purposes: (1) extend roof life; (2) provide architectural effects; and (3) act as a heat reflector. The roofer must know when coatings should be used and which specification is appropriate to meet existing conditions. Incorrectly applied, a coating job can be a waste of the customer's money and a reflection on the professional competence of the contractor.

Instructions

Before an attempt is made to perform this exercise, the following points should be considered in a classroom discussion:

- Is the surface to be coated absorbent or rough enough to require additional material?
- What percentage of waste may be expected?
- Will the prevailing temperature have any effect on the application procedure?
- What problems might arise if spraying must be done on a windy day?
- If a coating job involves a weathered deck, will it waterproof the deck adequately, or should the deck be replaced first?
- What preliminary preparations should be made before coating a capsheet, gravel, or tile roof?
- What different types of coatings are available for use, and what are their individual characteristics and purposes?

Suggested Reference Materials

1. Selected architectural drawings and specifications
2. Manufacturers' specification manuals
3. Blueprint Reading and Examination Kit (ATS)

Exercise

1. Using any suitable architectural drawing, working sketch, or actual structure, calculate the amount of roof coating required.

UNIT F--EXERCISES IN ESTIMATING

TOPIC 3--MATERIALS AND METHODS

Many customers are not aware that roofing applications and methods vary to the extent that several different estimates can be worked up on one job. Most customers will appreciate advice on these matters and a chance to make a choice. The roofer, therefore, should make three different estimates on a job, using three different job specifications.

Once the take-off measurements have been made, all that is necessary for the three estimate figures is to recalculate the cost per square of roofing, based on the materials to be used and the methods employed. This takes only a short time and often makes the difference between getting or losing the job. It also demonstrates to the customer that his interests are being considered.

Instructions

Class discussion should take place on the foregoing points before the estimating exercises are attempted. Variations in materials and methods should be explored as they might relate to the following types of deck construction:

1. 1" x 6" douglas fir deck with parapets
2. 1" x 6" douglas fir deck and concrete block parapet
3. 1/2-in. plywood deck and ceramic brick parapet
4. Concrete deck and parapet
5. Any of the various "lightweight" decks (gypsum, lightweight aggregate, or mineral lightweight aggregate)

Suggested Reference Materials

Selected architectural drawings

Exercises

Make estimates as follows, using a selected architectural drawing:

1. A very competitive bid, using the minimum building requirements existing in your area.

2. A minimum bid which, on the basis of your knowledge and experience, is designed to serve the customer best from the standpoint of durability, quality, ease of maintenance, and the like. Explain on a separate sheet of paper why you chose each part of your specification.

3. A bid using a manufacturer's 20-year bonded specification.

NOTE: Label the bids to indicate what they are--"Competitive Bid," "Quality Bid," or "Bonded Specification Bid."

UNIT F--EXERCISES IN ESTIMATING

TOPIC 4--RECOVER WORK

Many roof conditions require a repair or a recover job. The condition of an existing roof will determine which corrective action to take if the condition is analyzed carefully in the light of what has caused the failure to occur and what effects the failure will have on the roof's performance. Roof failures are not always easy to diagnose--for example, a leak in a skylight may have several causes: cracked solder joints, plugged weepholes, sagging drain, obstructed channels, and broken base flashings, to name a few.

The estimator should base his decision solely upon the cause-and-effect relationship, calling for a repair when that is all that is needed or ordering a recover job only when a repair will not suffice. He should never attempt to "oversell" just to secure a bigger job. Honesty and forthrightness in estimating are essential to long-range success and will never fail to establish a good reputation for the roofing firm involved.

Instructions

From the list of common roof conditions that follow, the instructor will select those which will govern the decisions of the students while working exercises 1, 2, and 3:

Built-up Roof - Recover Only

1. A number of existing applications
2. Ability of the existing structure to support additional load
3. Fishmouths
4. Blisters up to 12 inches
5. Blisters up to 10 feet
6. Loose granules
7. Splitting
8. Numerous patches
9. Leaks around scuppers and outlets
10. Water between existing roof application
11. Skylight leaking
12. Plugged weepholes
13. Leaks around flagpoles
14. Splitting and sagging around parapets
15. Reglet separating from wall
16. Holes in base flashing
17. Three-course flashing pulling loose
18. Pipes without flashing (new roof jacks or pitchpans)
19. Leaking expansion joints
20. Leaking at a tie-in
21. Leaking or cracked coping
22. Badly installed air conditioning equipment or ducts
23. Burned-out valleys
24. Severe condensation
25. Gravel off in various areas, exposing felt

Exercises

1. Estimate a competitive gravel recover job to conform to minimum codes. The building to be recovered is 60 years old and has three existing roof applications.

2. Working from blueprints, estimate for a quality job one that, in your opinion, will best serve the customer.

3. Working from the same blueprint, estimate for a capsheet application one that, in your opinion, will best serve the customer.

UNIT F--EXERCISES IN ESTIMATING

TOPIC 5--COMPOSITION SHINGLES

A quality job of shingling can be considerably more expensive than one performed on highly competitive work. The estimating exercises in this topic set up different sets of conditions and problems that may exist on a job. For example: sealing or flashing composition shingles to old wooden siding can be done the "proper" way (which is costly), or it can be done in a "satisfactory" manner (usually the case in competitive work). Proper Z bar can be installed as would be done on new work, or the shingles may only be sealed to the siding with flashing compound.

Instructions

Before an attempt is made to perform these exercises, the following points should be considered in a classroom discussion:

- Are very high quality shingles normally used on a class "A" or "B" structure which must provide maximum fire resistance?
- Is it possible that composition shingles cannot be applied over some roofs, even though the roof pitch is adequate?
- What are the normal mechanical precautions to take when shingling in freezing climates?

Suggested Reference Material

1. Manufacturers' specification manuals
2. Blueprint Reading and Examination Kit (ATS)
3. Other architectural drawings as needed

Exercises

Using the material in the Blueprint Reading and Examination Kit, make estimates in accordance with the following conditions:

1. A competitive bid on new work, within the minimum code requirements of your area.

2. A quality recover bid on the same structure. Assume the following when preparing the bid:
    (a) The house is 60 years old.
    (b) The existing wood shingles are deteriorated and brittle.
    (c) The shingle lath or sheathing is 1" x 3" and 10 in. on center.
    (d) The owner wants it covered with composition shingles.

Using a blueprint for a Group B occupancy structure, make estimates based on the following conditions:

3. A bid covering the use of a quality composition shingle for a bonded specification.
4. A bid similar to number 3, making allowance for the fact that the structure will be subjected to alternate freezing and thawing.

UNIT F--EXERCISES IN ESTIMATING

TOPIC 6--TILE AND CEMENT ASBESTOS

Estimating tile or other rigid roofing from a blueprint or job is the most efficient way of analyzing the problems that may be encountered when the work is performed. It is in this way that every contingency is considered and allowed for in advance of the job.

Suggested Reference Material

1. Selected tile specification manuals
2. Blueprint Reading and Examination Kit (ATS)
3. Selected architectural drawings suitable for estimating tile roofs

Exercises

Assuming that the roof to be covered is constructed to accept a 1,500 lb. per square tile, make estimates based on the following conditions:

1. Estimate the best quality new job of interlocking tile, using a suitable blueprint for the structure.

2. Estimate a tearoff and recover job, using tapered mission tile and ties on concrete deck.

3. Estimate a cement asbestos shingle roof for a new deck.

(NOTE: Thorough discussion and review should take place on each phase of each job before completing estimates.)

UNIT F--EXERCISES IN ESTIMATING

TOPIC 7--FOUNDATION WATERPROOFING

Foundation waterproofing jobs are not encountered as frequently as roofing, but such jobs are still an important part of the roofing trade. These exercises are designed to allow the apprentice to think through a complete job, step by step, as he completes the estimating forms.

Instructions

All phases of the work covered by the estimates should be discussed thoroughly in class before the exercises are attempted.

Suggested Reference Material

1. Blueprint Reading and Examination Kit (ATS)
2. Manufacturers' specification manuals
3. Selected construction blueprints

Assignment

1. Review Unit A, Topic 7, "Dampproofing and Waterproofing" in this workbook.

Exercises

1. Using any selected blueprint, estimate for dampproofing only.

2. Using the material in the Blueprint Reading and Examination Kit, estimate for a floor membrane.

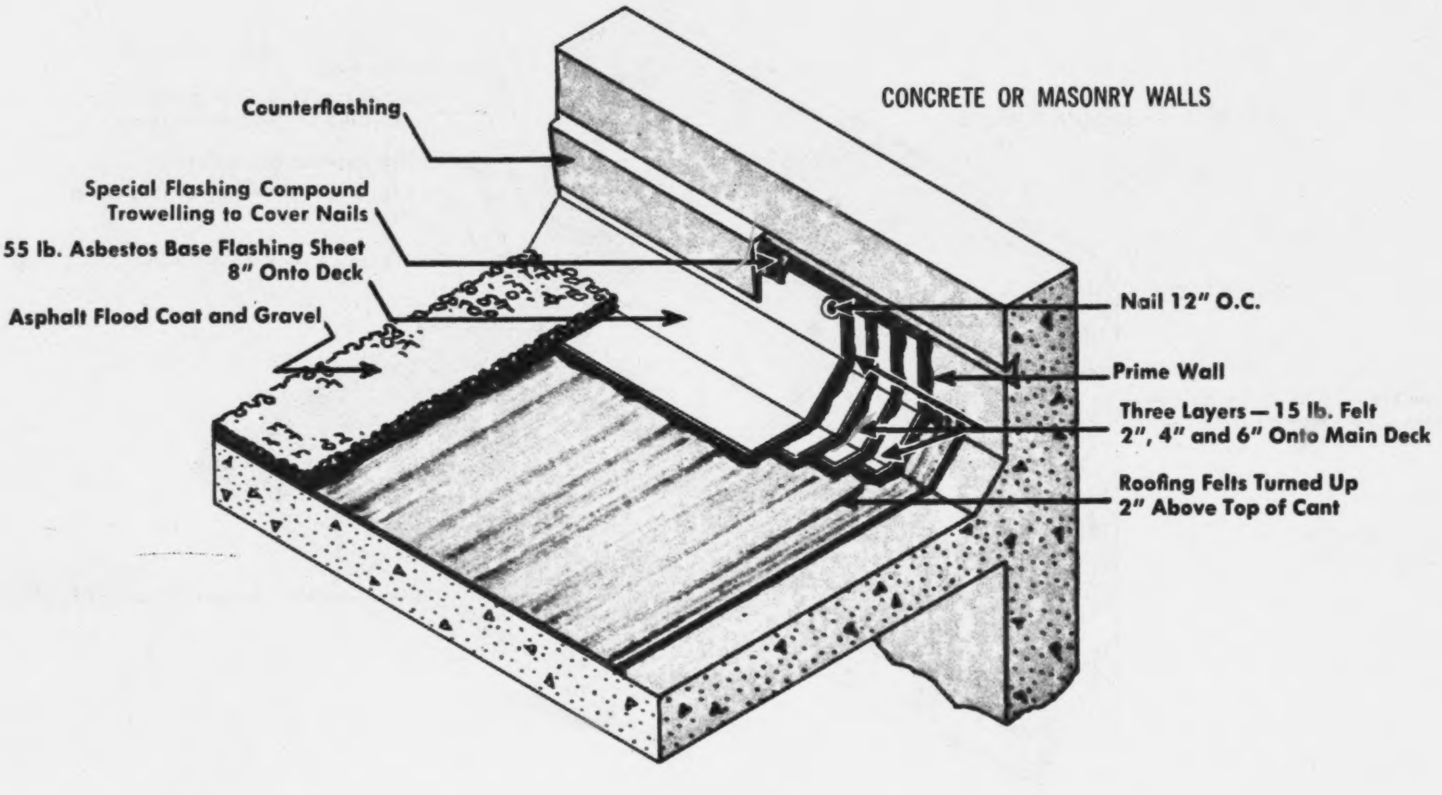
3. Using any selected blueprint of a Class "A" structure, estimate for waterproofing against hydrostatic pressure. For this estimate, figure on using a membrane.

4. Estimate the job as outlined in Exercise No. 3, but figure for a sprayed, plastic-type coating over a floating membrane.

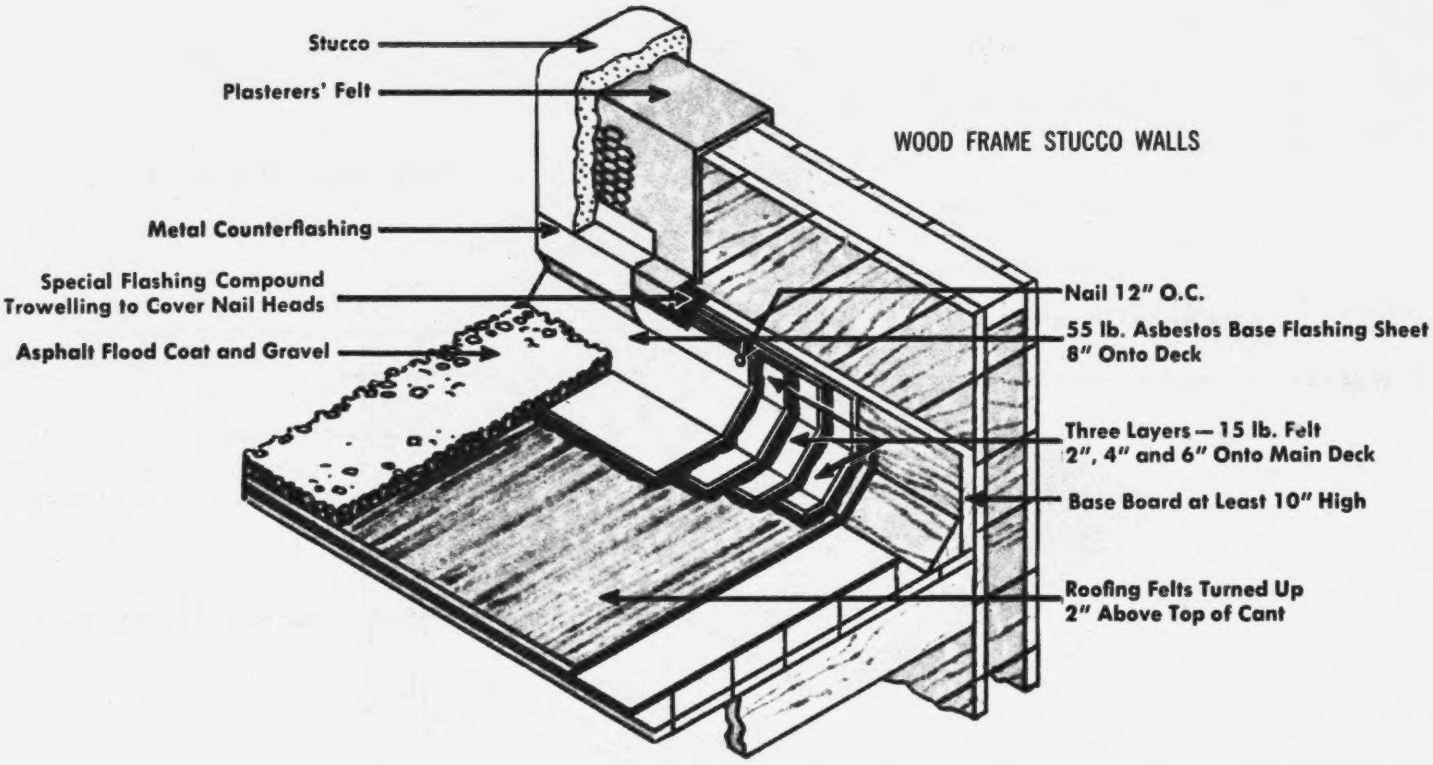
SUPPLEMENTARY ART

The following illustrations, consisting of sections, details, plan views, and elevation views, are referred to throughout the text. Many of these illustrations may also be used for the study of construction methods, installation procedures, estimating, and blueprint reading. All the illustrations are typical of those used everyday in the roofing industry.

The apprentice should also make full use of AIS specifications, manufacturers' catalogs and brochures, and any other literature published for the purpose of introducing, describing, or illustrating new developments, techniques, or materials in the roofing trade.

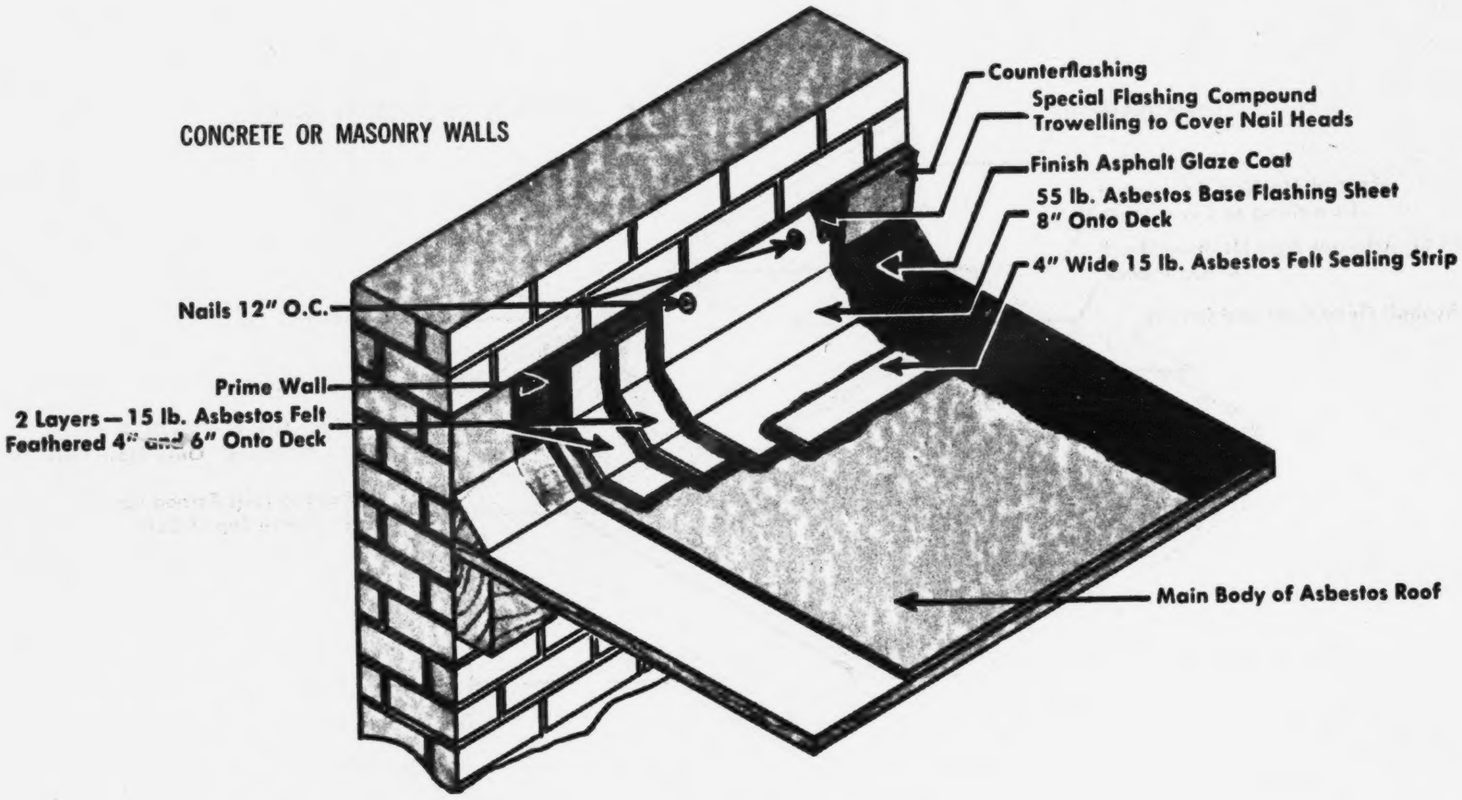

CONCRETE OR MASONRY WALLS
Counterflashing
Special Flashing Compound Trowelling to Cover Nails
55 lb. Asbestos Base Flashing Sheet 8" Onto Deck
Asphalt Flood Coat and Gravel
Nail 12" O.C.
Prime Wall
Three Layers — 15 lb. Felt 2", 4" and 6" Onto Main Deck
Roofing Felts Turned Up 2" Above Top of Cant

DETAIL A^1-A^1

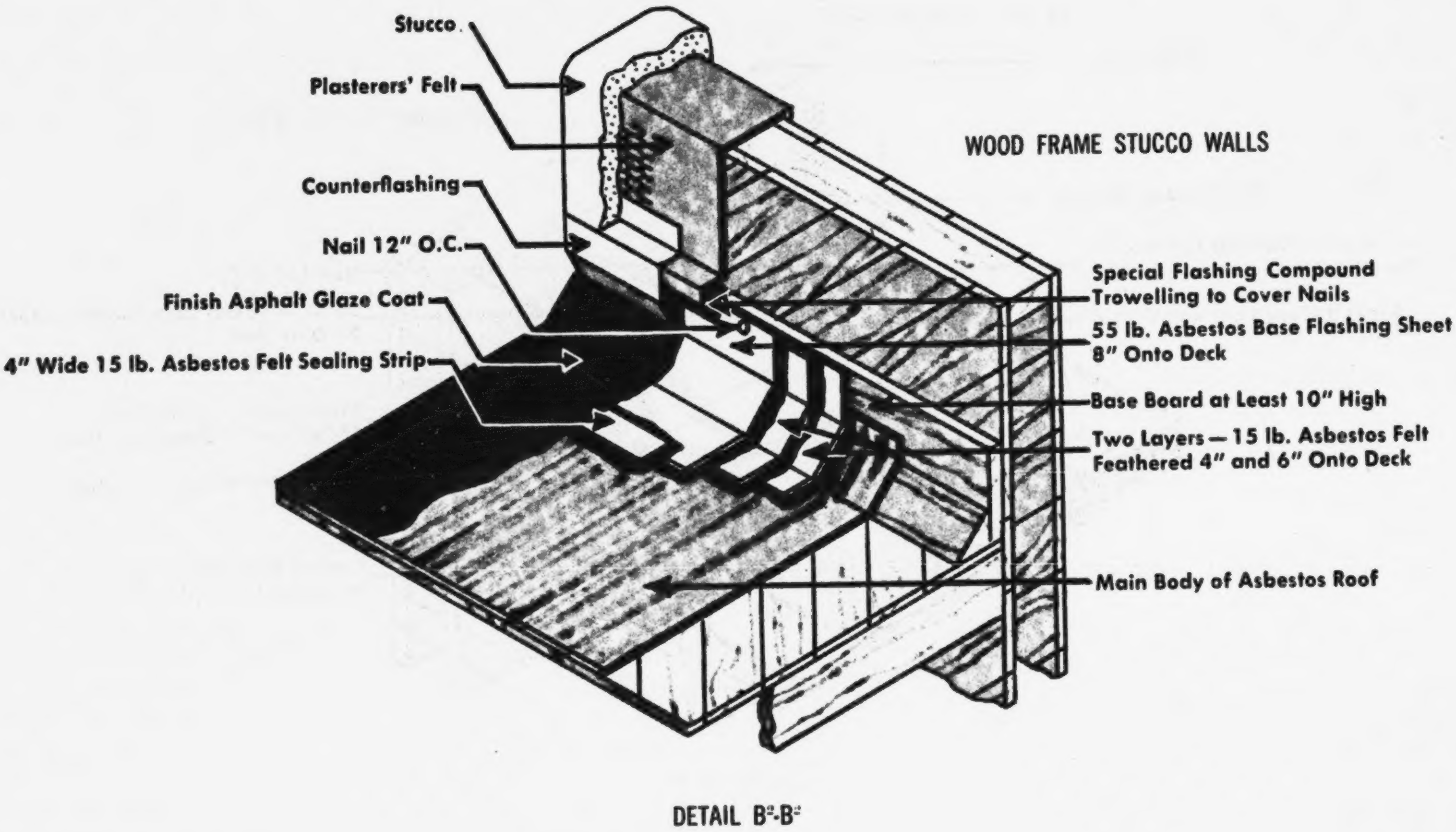

WOOD FRAME STUCCO WALLS
Stucco
Plasterers' Felt
Metal Counterflashing
Special Flashing Compound Trowelling to Cover Nail Heads
Asphalt Flood Coat and Gravel
Nail 12" O.C.
55 lb. Asbestos Base Flashing Sheet 8" Onto Deck
Three Layers — 15 lb. Felt 2", 4" and 6" Onto Main Deck
Base Board at Least 10" High
Roofing Felts Turned Up 2" Above Top of Cant

DETAIL A^2-A^2

Fig. F-1. Flashing on gravel roofs

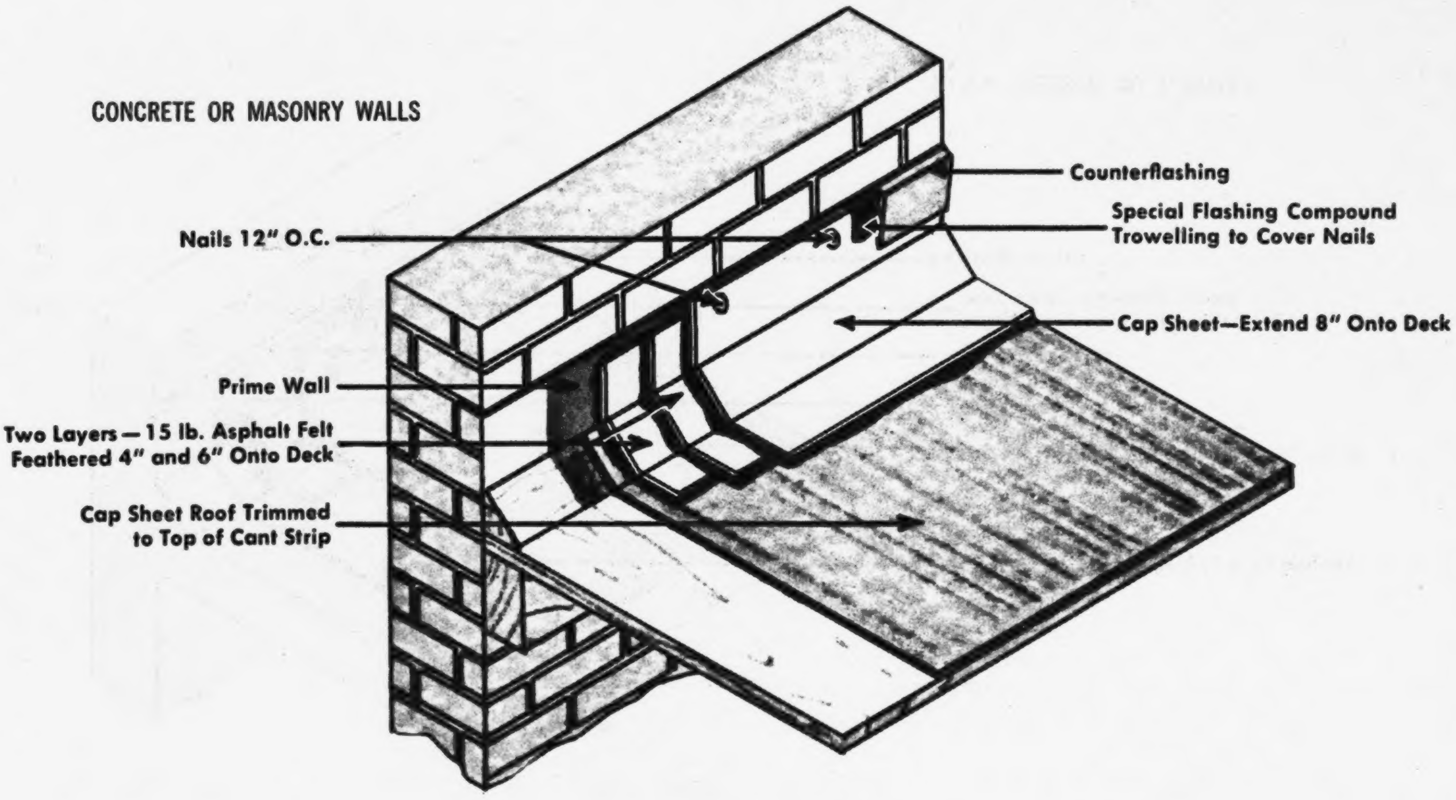

CONCRETE OR MASONRY WALLS
Counterflashing
Special Flashing Compound Trowelling to Cover Nail Heads
Finish Asphalt Glaze Coat
55 lb. Asbestos Base Flashing Sheet 8" Onto Deck
4" Wide 15 lb. Asbestos Felt Sealing Strip
Nails 12" O.C.
Prime Wall
2 Layers — 15 lb. Asbestos Felt Feathered 4" and 6" Onto Deck
Main Body of Asbestos Roof

DETAIL B^1-B^1

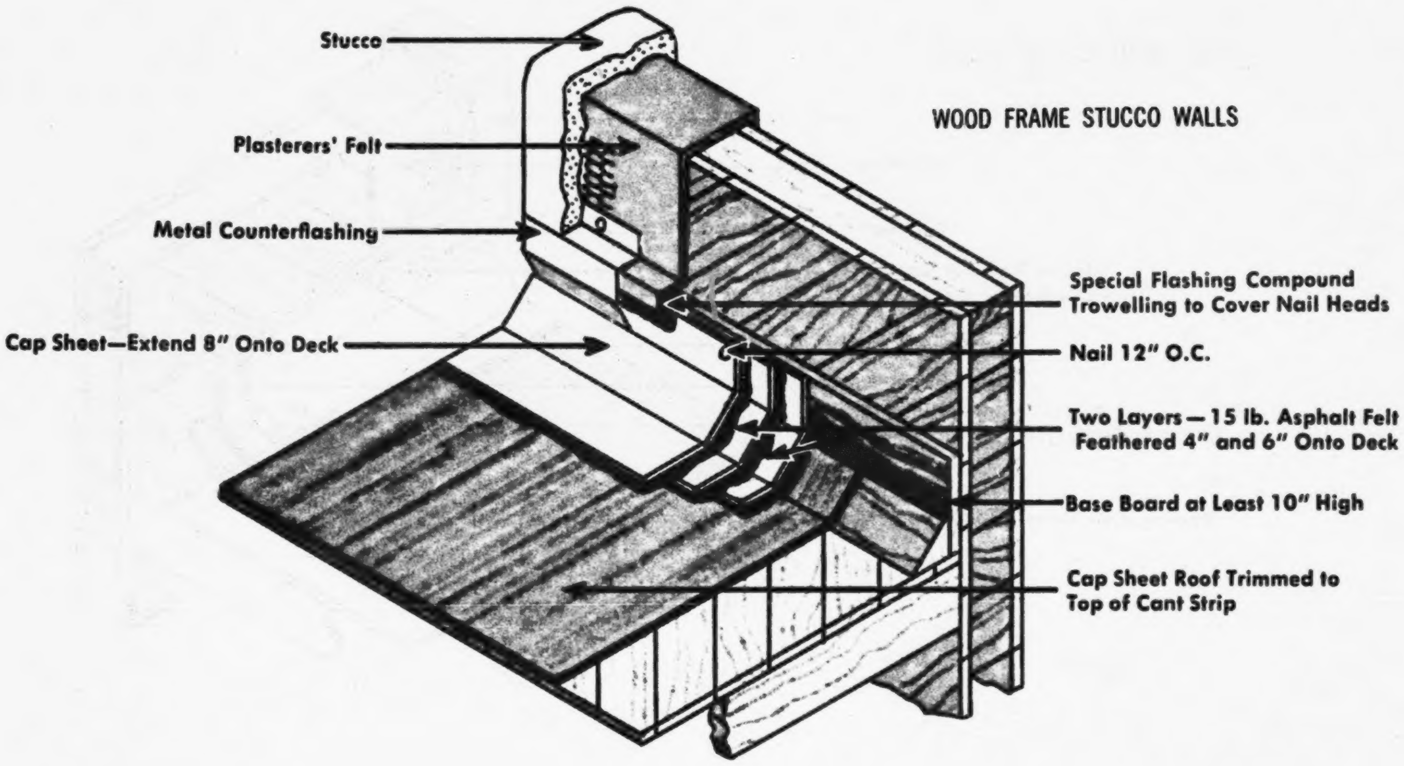

Stucco
Plasterers' Felt
WOOD FRAME STUCCO WALLS
Counterflashing
Nail 12" O.C.
Finish Asphalt Glaze Coat
4" Wide 15 lb. Asbestos Felt Sealing Strip
Special Flashing Compound Trowelling to Cover Nails
55 lb. Asbestos Base Flashing Sheet 8" Onto Deck
Base Board at Least 10" High
Two Layers — 15 lb. Asbestos Felt Feathered 4" and 6" Onto Deck
Main Body of Asbestos Roof

DETAIL B^2-B^2

Fig. F-2. Flashing for smooth surface asbestos roofs


CONCRETE OR MASONRY WALLS
Counterflashing
Special Flashing Compound Trowelling to Cover Nails
Nails 12" O.C.
Cap Sheet—Extend 8" Onto Deck
Prime Wall
Two Layers — 15 lb. Asphalt Felt Feathered 4" and 6" Onto Deck
Cap Sheet Roof Trimmed to Top of Cant Strip

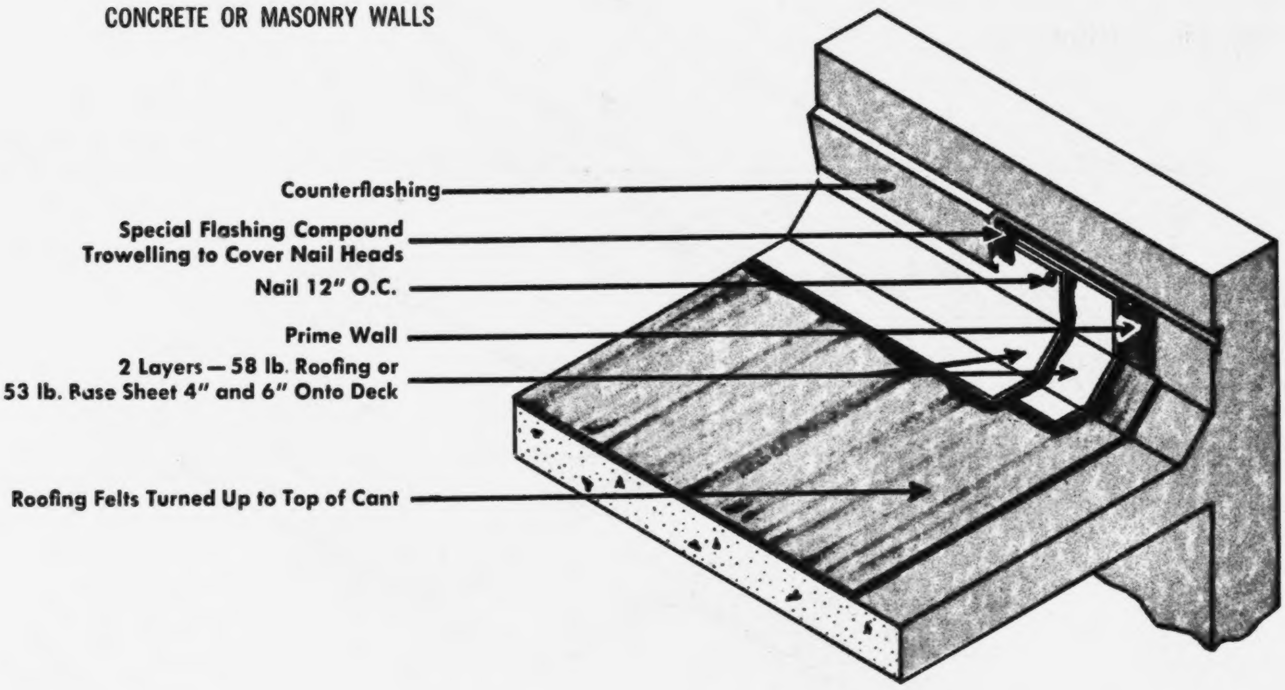
DETAIL C^1-C^1


Stucco
WOOD FRAME STUCCO WALLS
Plasterers' Felt
Metal Counterflashing
Special Flashing Compound Trowelling to Cover Nail Heads
Cap Sheet—Extend 8" Onto Deck
Nail 12" O.C.
Two Layers — 15 lb. Asphalt Felt Feathered 4" and 6" Onto Deck
Base Board at Least 10" High
Cap Sheet Roof Trimmed to Top of Cant Strip

DETAIL C^2-C^2

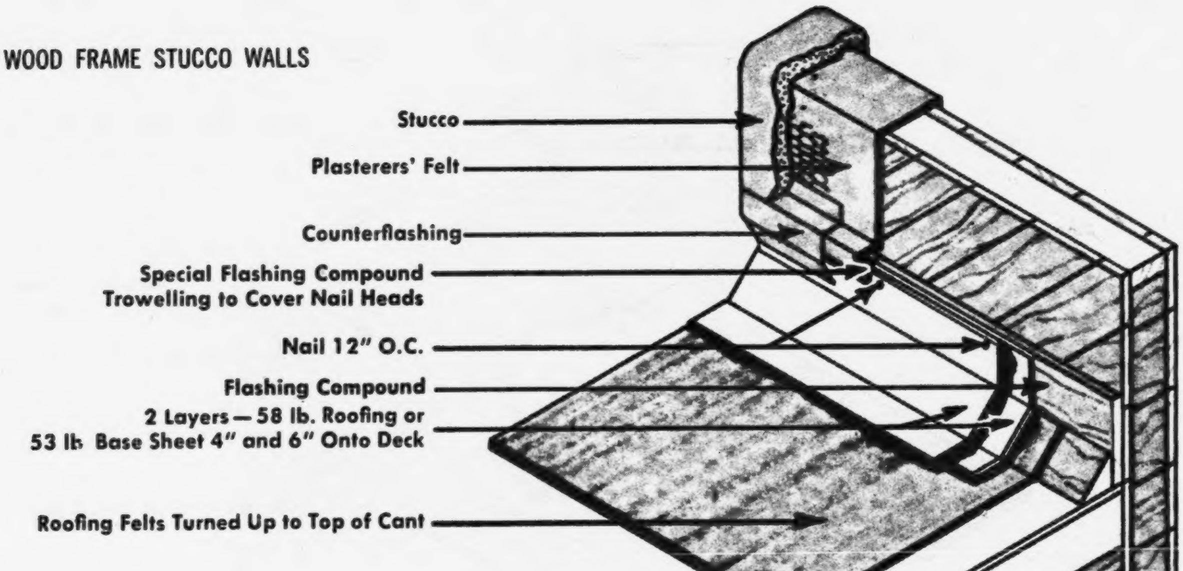
Fig. F-3. Flashing for capsheet, slate, mineral, and alumi-shield roofs

CONCRETE OR MASONRY WALLS


Counterflashing
Special Flashing Compound Trowelling to Cover Nail Heads
Nail 12" O.C.
Prime Wall
2 Layers — 58 lb. Roofing or 53 lb. Base Sheet 4" and 6" Onto Deck
Roofing Felts Turned Up to Top of Cant

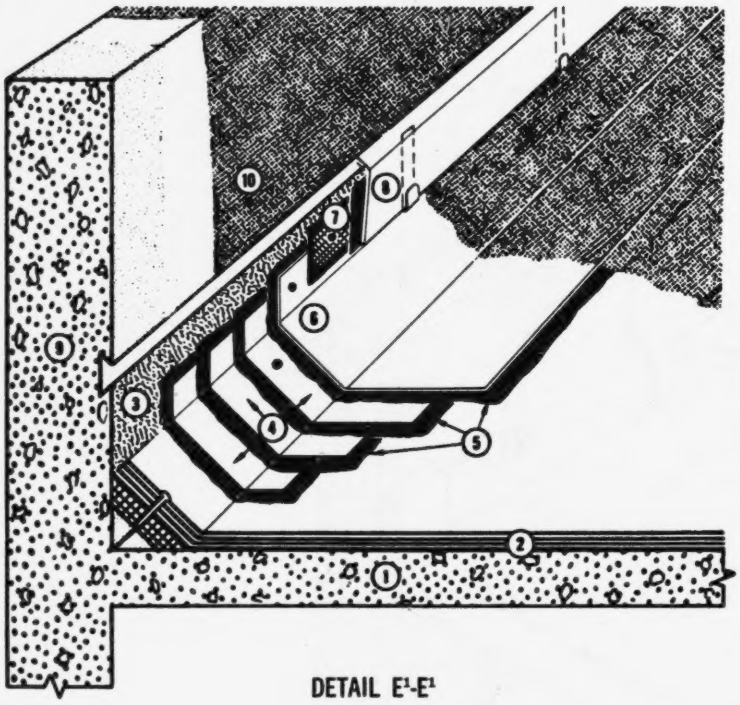
DETAIL D^1-D^1

WOOD FRAME STUCCO WALLS


Stucco
Plasterers' Felt
Counterflashing
Special Flashing Compound Trowelling to Cover Nail Heads
Nail 12" O.C.
Flashing Compound
2 Layers — 58 lb. Roofing or 53 lb Base Sheet 4" and 6" Onto Deck
Roofing Felts Turned Up to Top of Cant

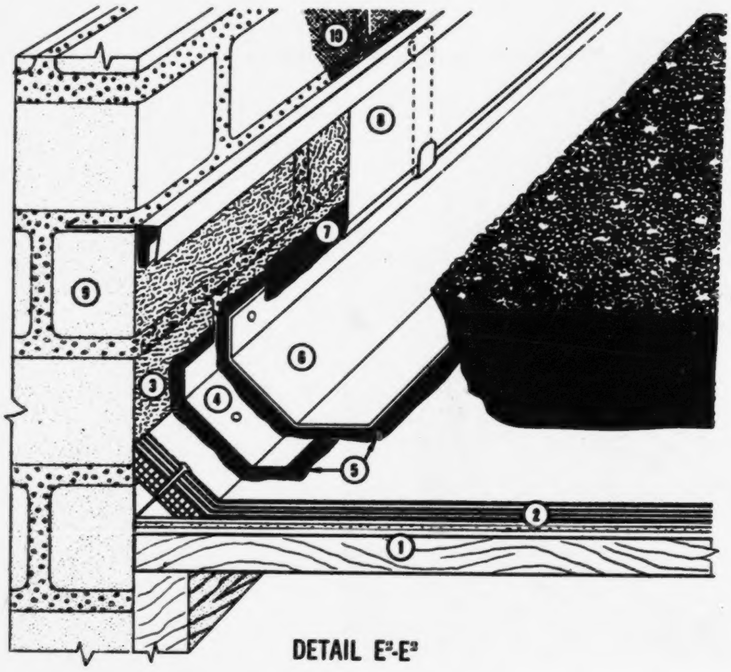
DETAIL D^2-D^2

Fig. F-4. Flashing for use with cold process assemblies



DETAIL E^1-E^1

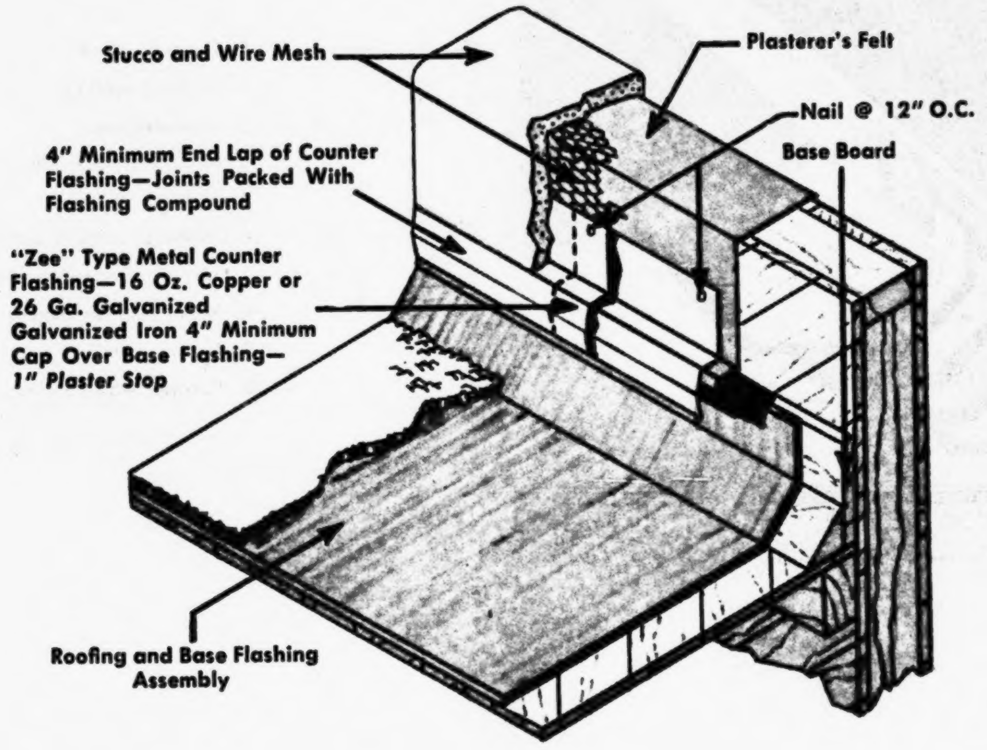
1. Concrete deck
2. Built-up roofing
3. Asphalt primer
4. No. 15 asphalt felt
5. Asphalt moppings
6. Mineral surfaced capsheet
7. Three-course plastic flashing
8. Metal counterflashing
9. Masonry wall
10. Parapet wall coating



DETAIL E^2-E^2

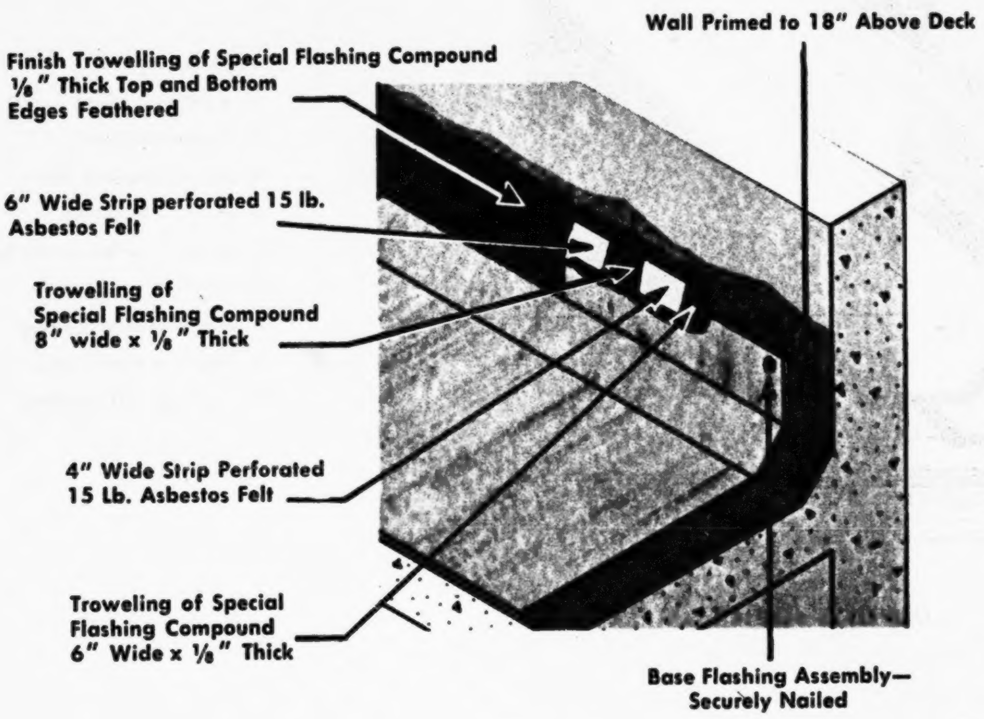
1. Wood deck
2. Built-up roofing
3. Asphalt primer
4. No. 15 asphalt felt
5. Asphalt mopping
6. Mineral surfaced capsheet
7. Flashing compound
8. Metal counterflashing
9. Masonry block wall
10. Parapet wall coating

Fig. F-5. Metal counterflashing on concrete or stucco walls


Stucco and Wire Mesh
Plasterer's Felt
Nail @ 12" O.C.
Base Board
4" Minimum End Lap of Counter Flashing—Joints Packed With Flashing Compound
"Zee" Type Metal Counter Flashing—16 Oz. Copper or 26 Ga. Galvanized Galvanized Iron 4" Minimum Cap Over Base Flashing—
1" Plaster Stop
Roofing and Base Flashing Assembly

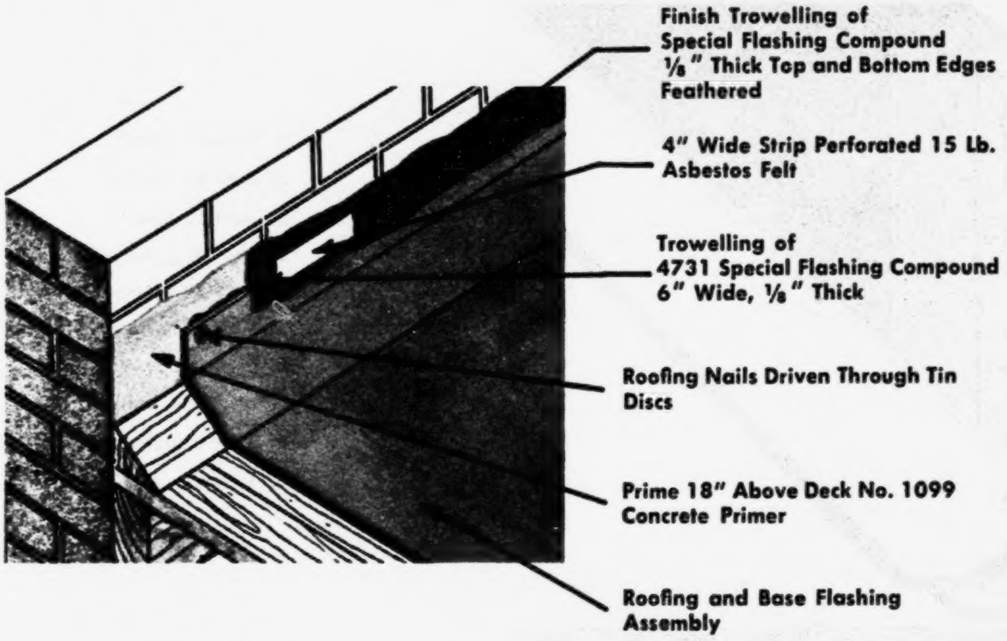
DETAIL F-F

Fig. F-6. Metal counterflashing and stucco stop for wood frame and stucco walls


Wall Primed to 18" Above Deck
Finish Trowelling of Special Flashing Compound ⅛" Thick Top and Bottom Edges Feathered
6" Wide Strip perforated 15 lb. Asbestos Felt
Trowelling of Special Flashing Compound 8" wide x ⅛" Thick
4" Wide Strip Perforated 15 Lb. Asbestos Felt
Troweling of Special Flashing Compound 6" Wide x ⅛" Thick
Base Flashing Assembly—Securely Nailed

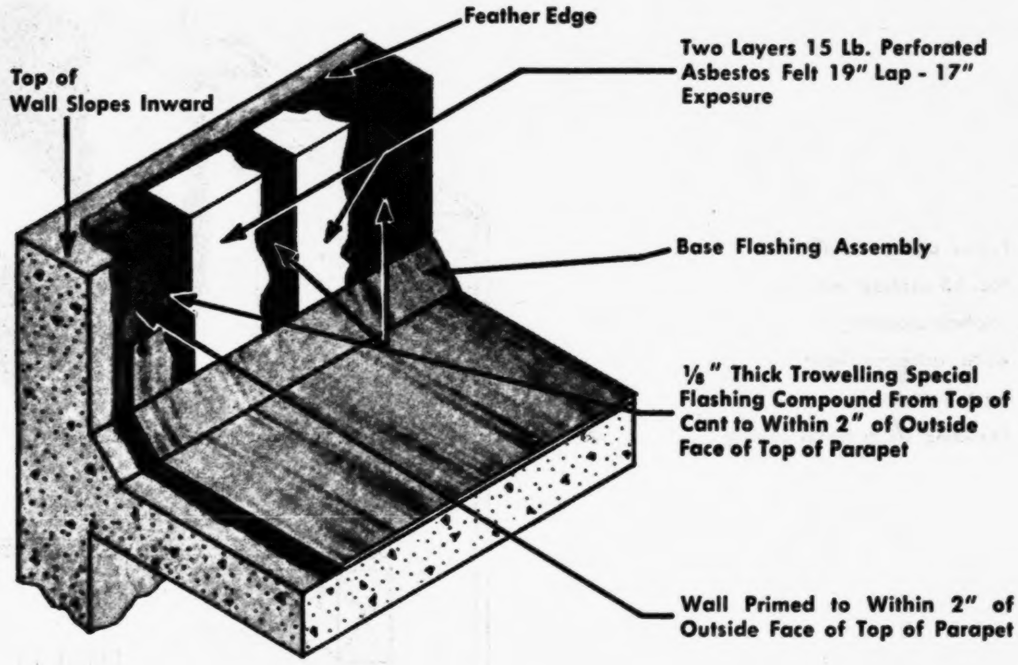
DETAIL G-G

Fig. F-7. Five-course plastic flashing for concrete walls more than 18 inches high


Finish Trowelling of Special Flashing Compound ⅛" Thick Top and Bottom Edges Feathered
4" Wide Strip Perforated 15 Lb. Asbestos Felt
Trowelling of 4731 Special Flashing Compound 6" Wide, ⅛" Thick
Roofing Nails Driven Through Tin Discs
Prime 18" Above Deck No. 1099 Concrete Primer
Roofing and Base Flashing Assembly

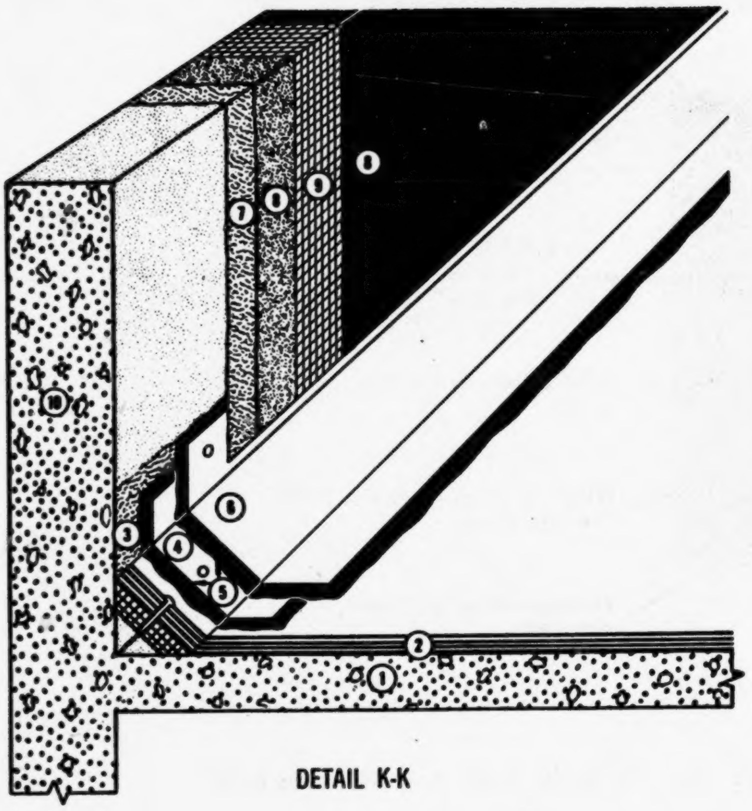
DETAIL H-H

Fig. F-8. Three-course plastic flashing for concrete walls more than 18 inches high


Feather Edge
Top of Wall Slopes Inward
Two Layers 15 Lb. Perforated Asbestos Felt 19" Lap - 17" Exposure
Base Flashing Assembly
⅛" Thick Trowelling Special Flashing Compound From Top of Cant to Within 2" of Outside Face of Top of Parapet
Wall Primed to Within 2" of Outside Face of Top of Parapet

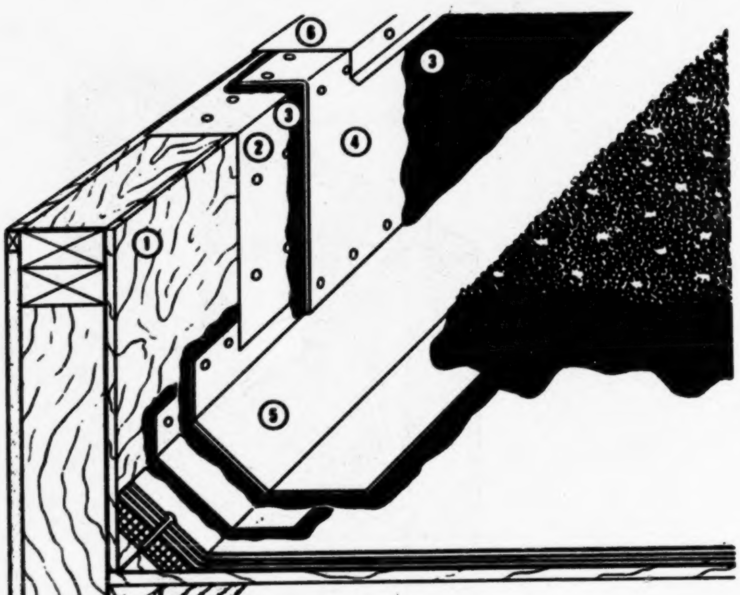
DETAIL J-J

Fig. F-9. Five-course plastic cap flashing for parapet walls less than 18 inches high



1. Concrete deck
2. Built-up roofing
3. Asphalt primer
4. No. 15 asphalt felt
5. Asphalt moppings
6. Mineral surfaced capsheet
7. Emulsion primer
8. Asphalt emulsion
9. Yellow jacket glass fabric
10. Masonry wall

Fig. F-10. Flashing on a masonry parapet wall



1. Frame parapet wall
2. No. 15 asphalt felt
3. Asphalt mopping
4. 45-lb. asbestos sheet
5. Base flashing
6. Standing seam metal coping

Fig. F-11. Flashing on a wooden parapet wall

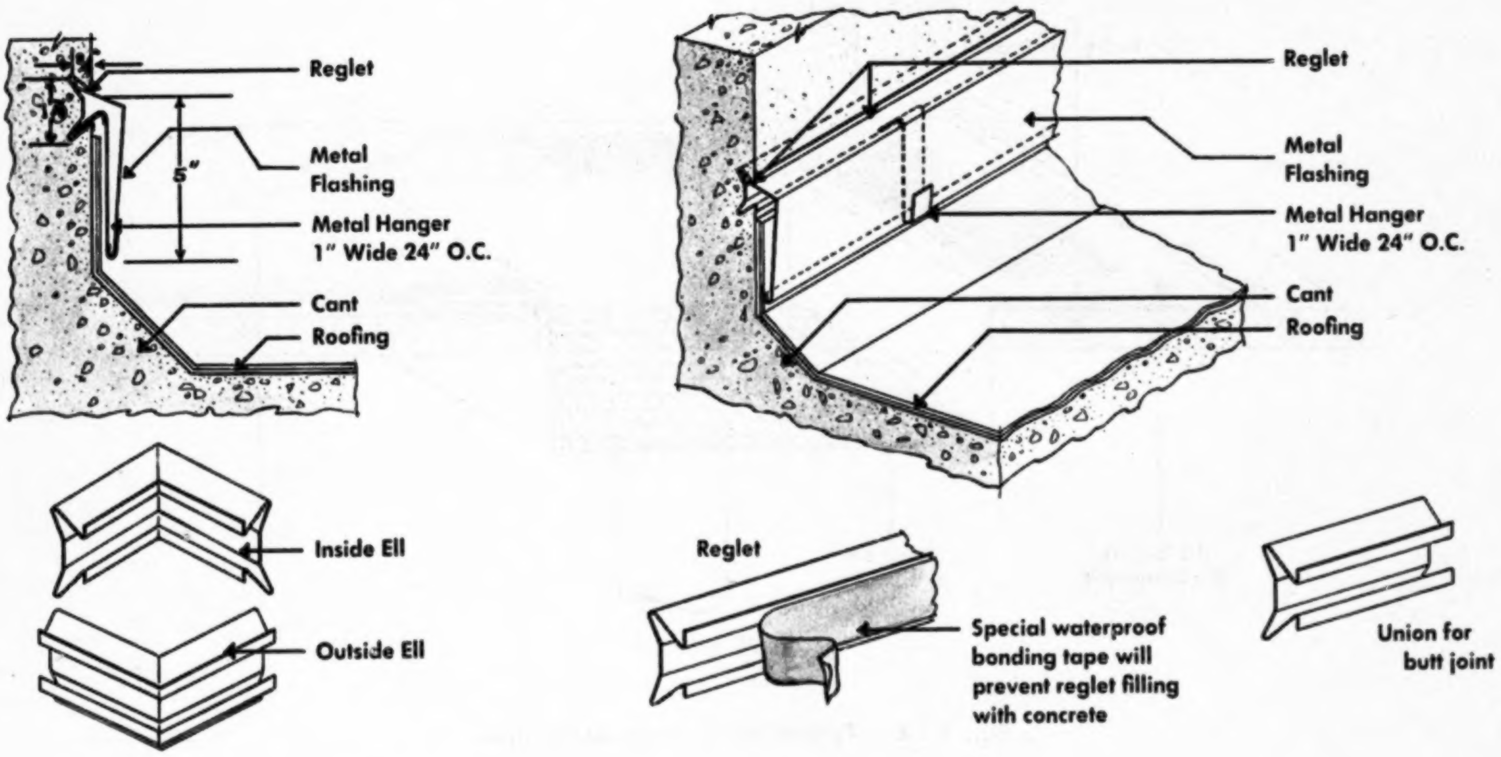
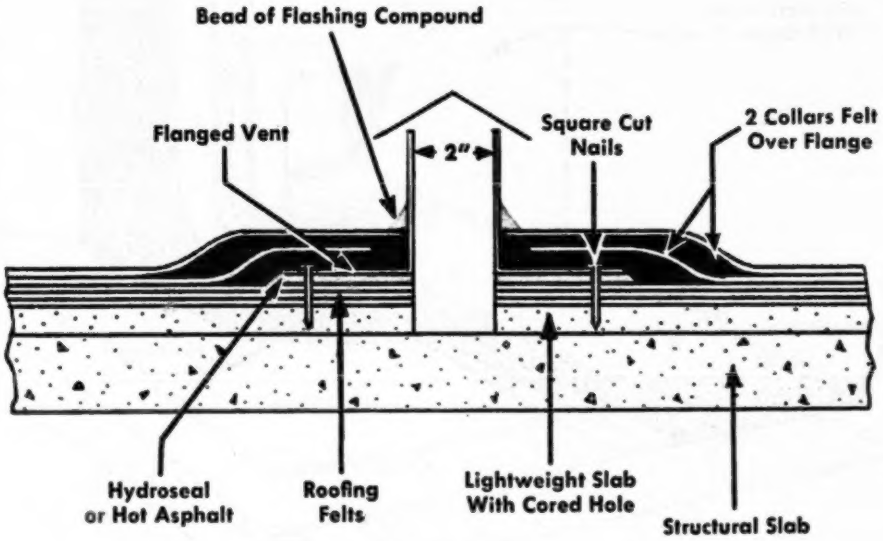
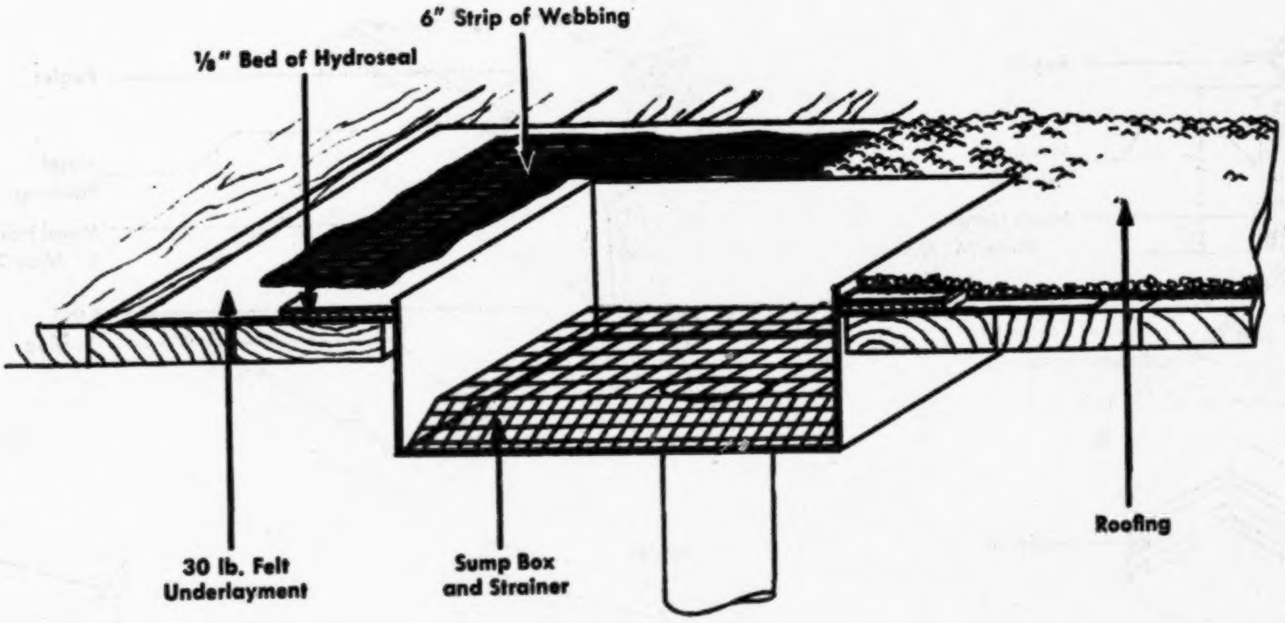

Reglet
Metal Flashing
5"
Metal Hanger 1" Wide 24" O.C.
Cant
Roofing
Inside Ell
Outside Ell
Reglet
Metal Flashing
Metal Hanger 1" Wide 24" O.C.
Cant
Roofing
Reglet
Special waterproof bonding tape will prevent reglet filling with concrete
Union for butt joint

Fig. F-12. Removable type of wall counterflashing


Bead of Flashing Compound
Flanged Vent
2"
Square Cut Nails
2 Collars Felt Over Flange
Hydroseal or Hot Asphalt
Roofing Felts
Lightweight Slab With Cored Hole
Structural Slab

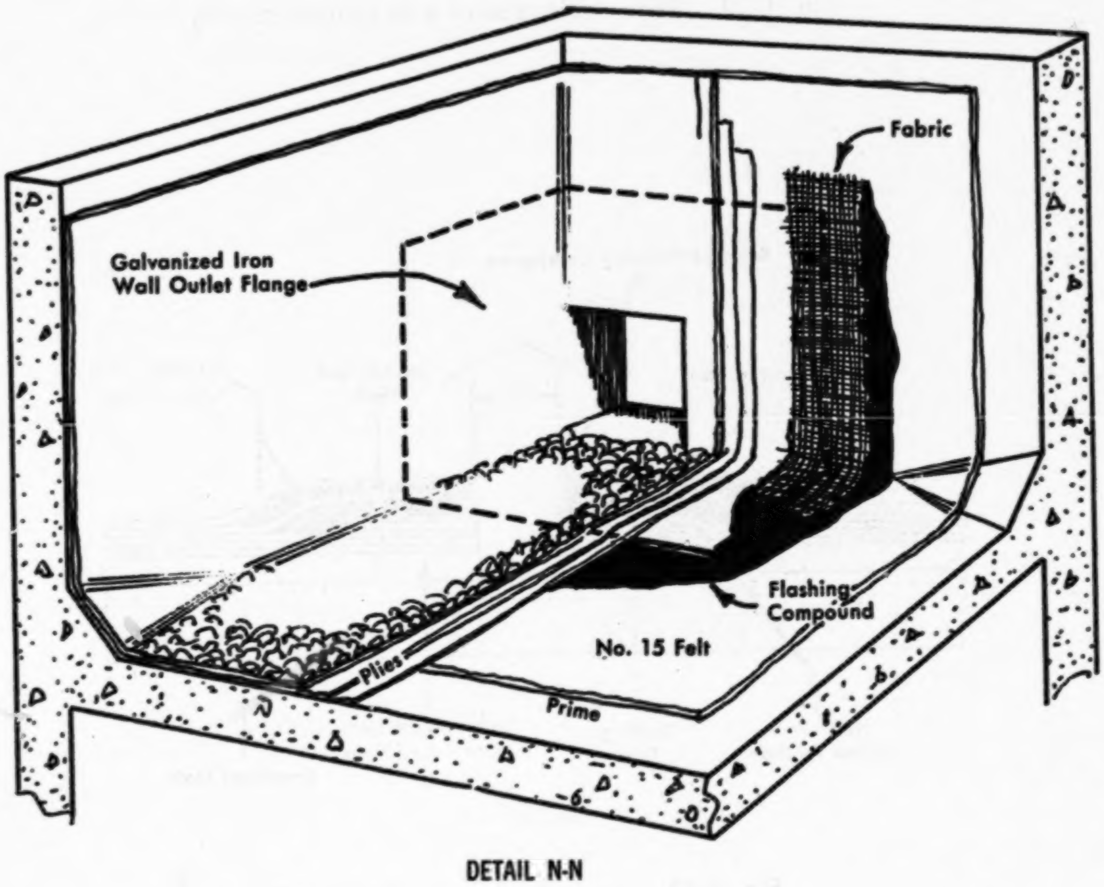
SECTION a-a

Fig. F-13. Typical pressure release vent


6" Strip of Webbing
⅛" Bed of Hydroseal
30 lb. Felt Underlayment
Sump Box and Strainer
Roofing

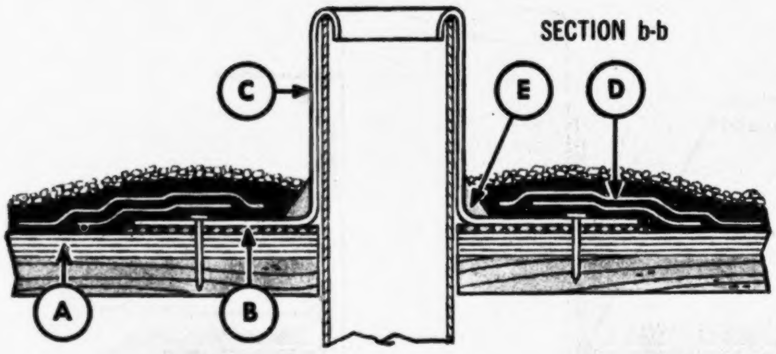
DETAIL M-M

Fig. F-14. Typical sump drain installation


Fabric
Galvanized Iron Wall Outlet Flange
Flashing Compound
No. 15 Felt
Plies
Prime

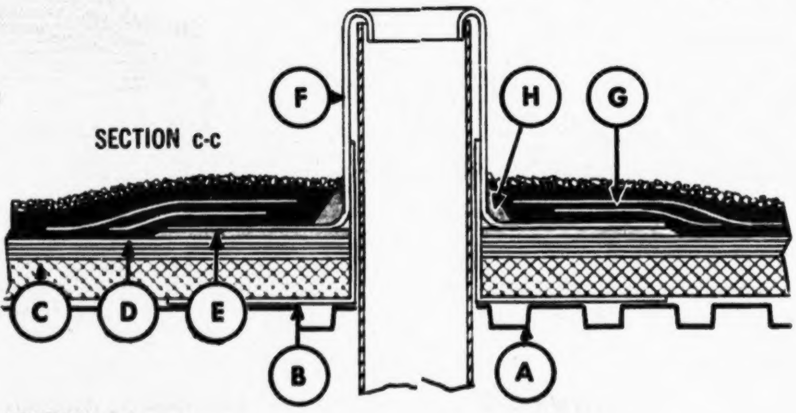
DETAIL N-N

Fig. F-15. Typical installation of overflow drain



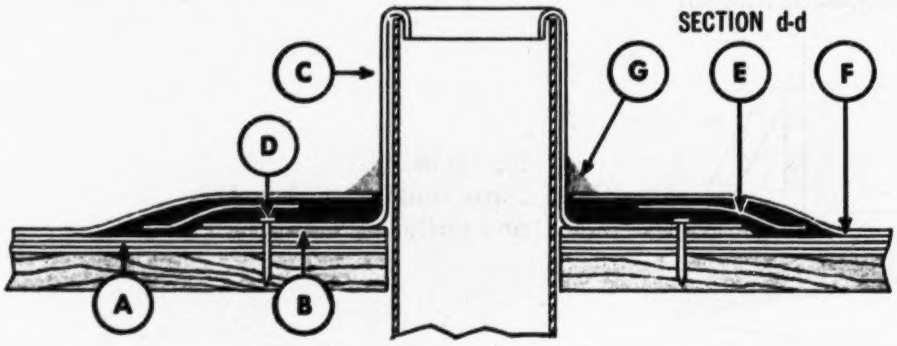
A. Roofing felts
B. Flashing compound (⅛ in. thick)
C. Lead vent pipe flashing in bed of flashing compound, turned down inside pipe
D. Two layers of felt set in asphalt over flange of lead vent pipe flashing
E. Bead of flashing compound encircling flashing

GRAVEL-SURFACED ROOF, SINGLE SLEEVE



A. Steel deck
B. Inner bottom sleeve extending at least 2 in. above final roof level
C. Insulation
D. Roofing felts
E. Flashing compound (⅛ in. thick)
F. Lead vent pipe top flashing
G. Two layers of felt set in asphalt
H. Bead of flashing compound

GRAVEL-SURFACED ROOF, DOUBLE SLEEVE

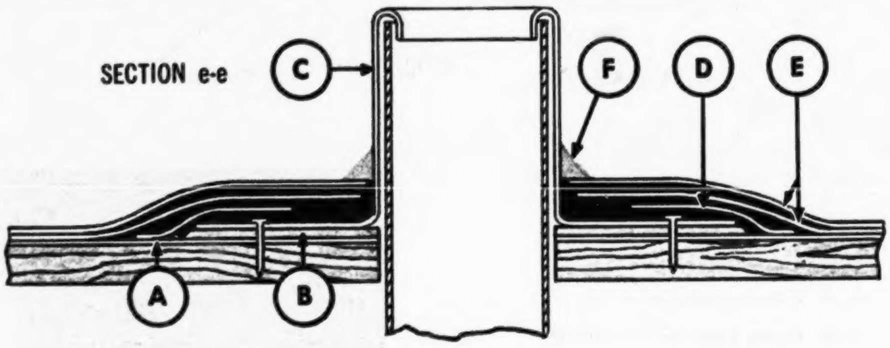


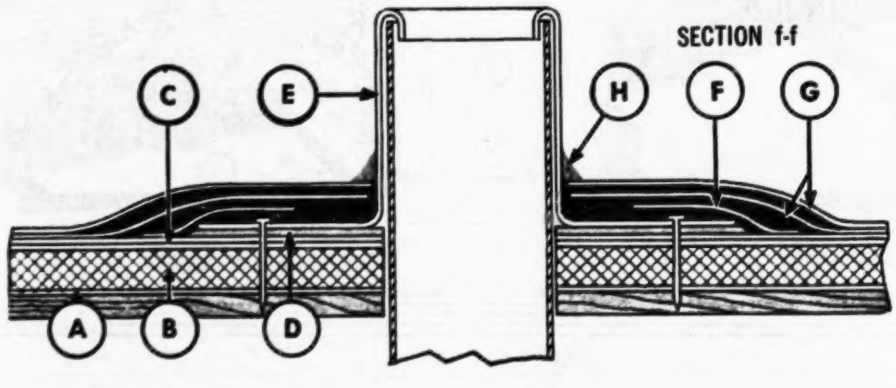
A. Roofing felts
B. Flashing compound (⅛ in. thick)
C. Lead vent pipe flashing
D. Nails
E. 6-in. strip of webbing
F. Capsheet
G. Bead of flashing compound

CAPSHEET ROOFS

A. Base sheet
B. Flashing compound (⅛ in. thick)
C. Lead vent pipe flashing
D. 6-in. strip of webbing
E. Finishing felts for smooth surface roofing
F. Bead of flashing compound

SMOOTH-SURFACED ROOF WITH BASE SHEET



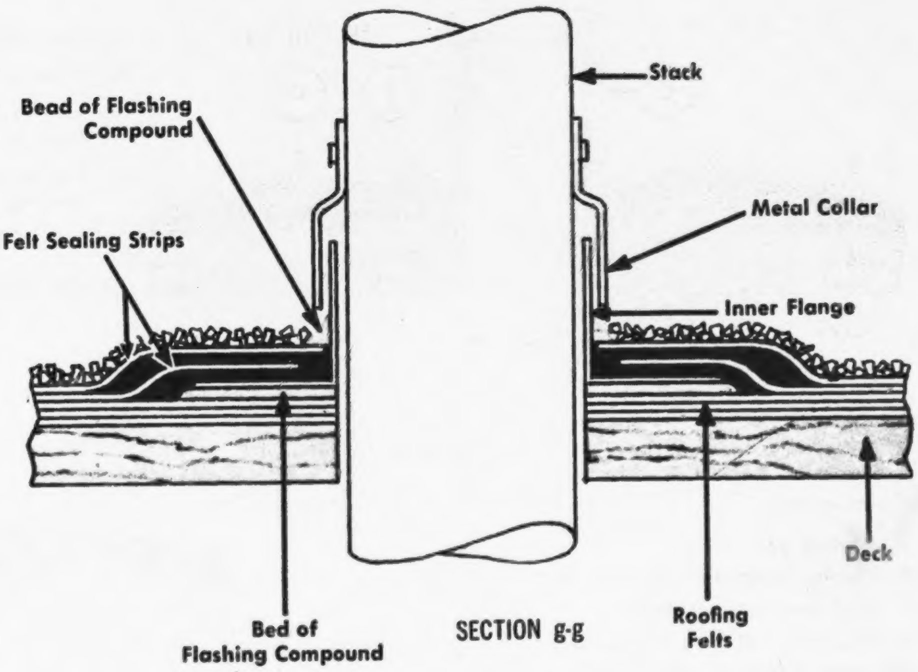


A. Vapor barrier
B. Insulation
C. Bottom two layers of 15-lb. asbestos felt
D. Flashing compound (⅛ in. thick)
E. Lead vent pipe flashing
F. 6-in. strip of webbing
G. Top two layers of asbestos felt
H. Bead of flashing compound

ASBESTOS FELTS OVER INSULATION

Fig. F-16. Lead sleeve installations

Fig. F-17.
Collars for large stacks and flagpoles


Stack
Bead of Flashing Compound
Metal Collar
Felt Sealing Strips
Inner Flange
Deck
Bed of Flashing Compound
SECTION g-g
Roofing Felts

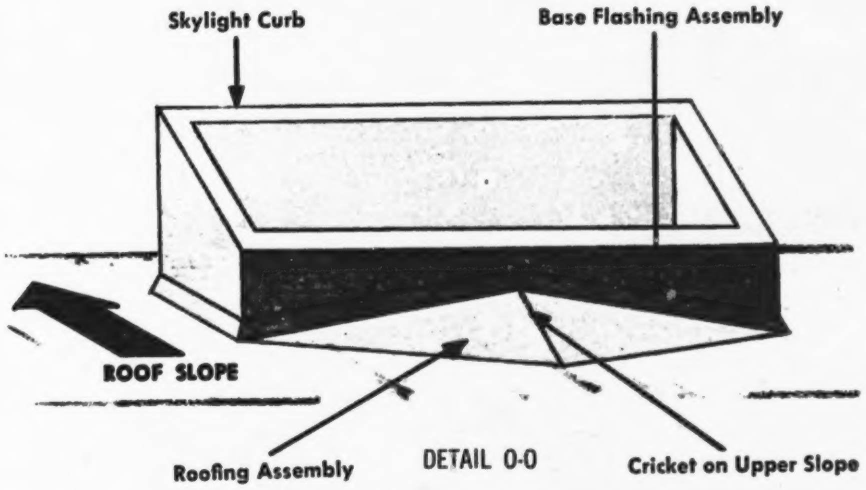

Skylight Curb
Base Flashing Assembly
ROOF SLOPE
Roofing Assembly
DETAIL O-O
Cricket on Upper Slope

Fig. F-18.
Large ventilators, skylights, and similar structures

1. Wood roof deck
2. Built-up roofing
3. Metal projection
4. Metal pan collar flashing
5. Yellow jacket glass fabric (6" wide)
6. No. 15 asphalt felt (12" wide)
7. Asphalt mopping
8. Flashing compound

DETAIL P-P

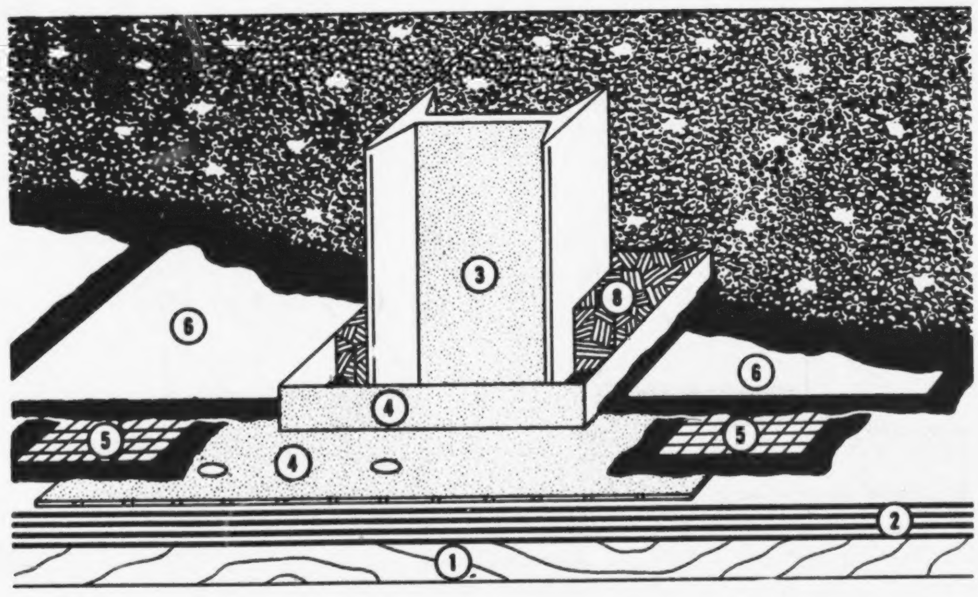

③
⑧
⑥
⑥
④
⑤
⑤
④
②
①

Fig. F-19. Metal pan collar flashing

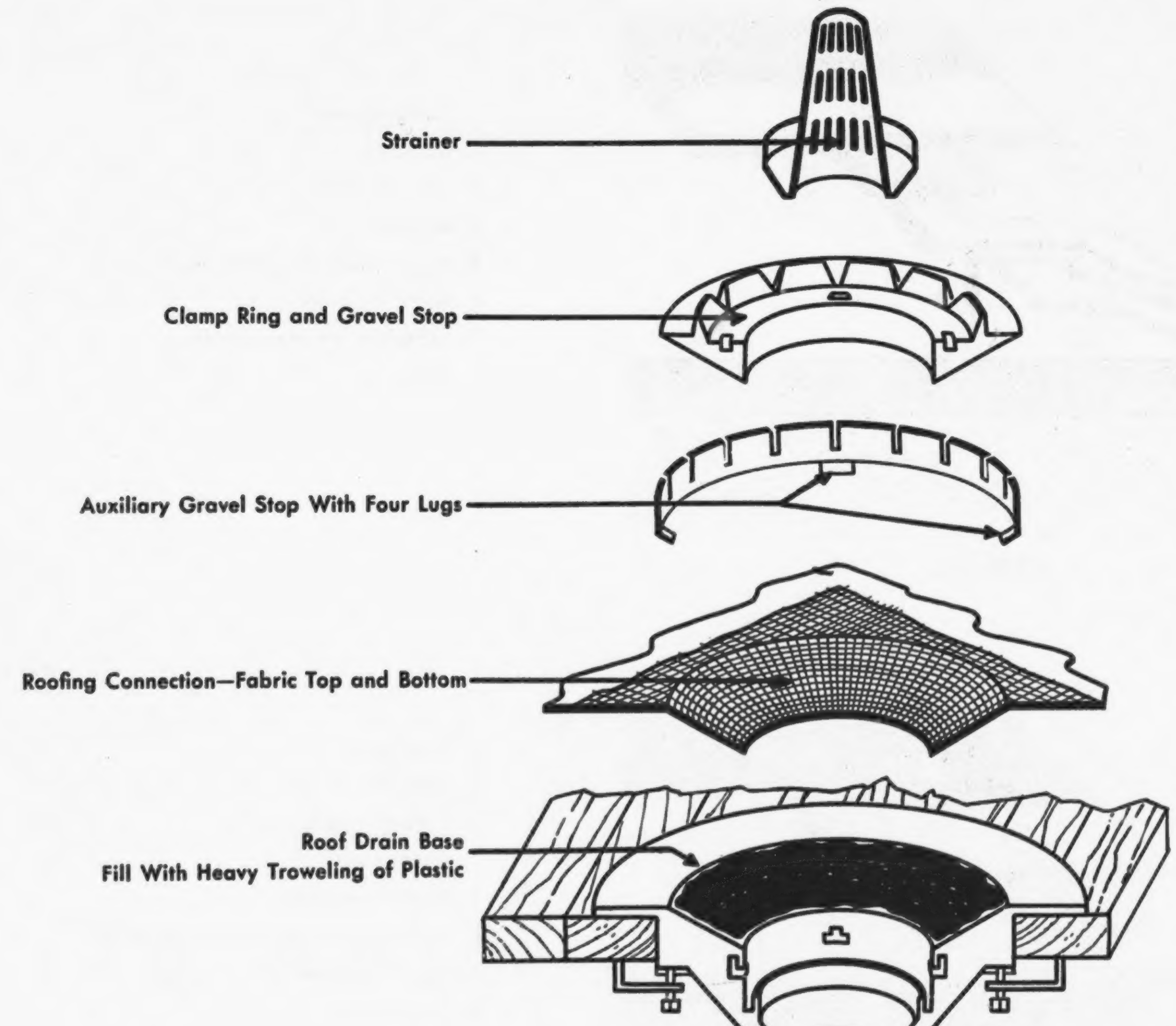
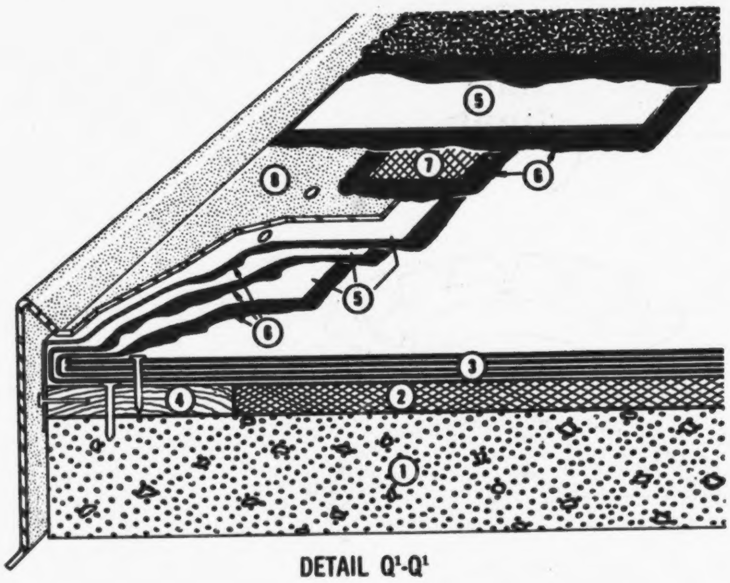
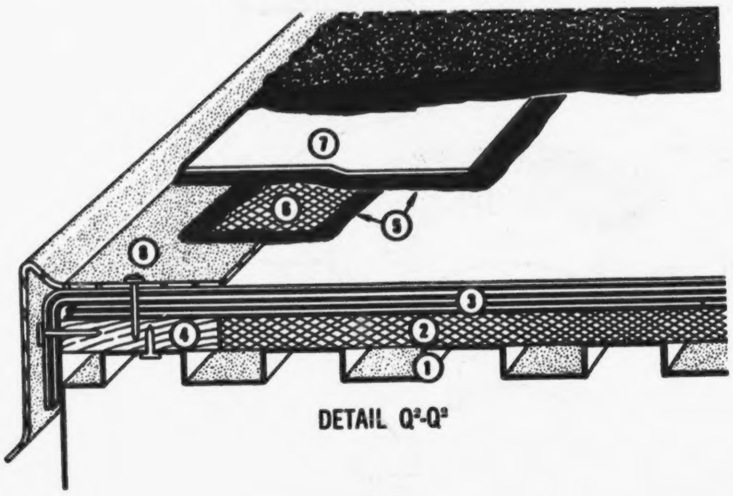

Strainer
Clamp Ring and Gravel Stop
Auxiliary Gravel Stop With Four Lugs
Roofing Connection—Fabric Top and Bottom
Roof Drain Base
Fill With Heavy Troweling of Plastic
Clamp Ring and Gravel Stop
Felt Plies Feathered at Least
One Ply Under Clamp Ring
ROOF DECK
Roofing Connection—Fabric Top and Bottom
Roof Drain Base
Fill With Heavy Troweling of Plastic
SECTION h-h

Fig. F-20. Drain and clamp rings



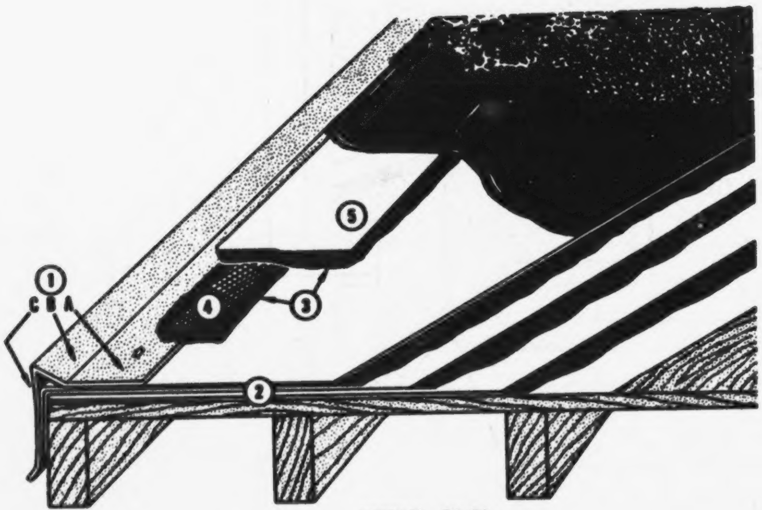
DETAIL Q^1-Q^1

1. Concrete deck
2. Insulation
3. Built-up roofing
4. Wood nailer
5. No. 15 asphalt enveloping felts
6. Asphalt mopping
7. Yellow jacket glass fabric
8. Gravel stop



DETAIL Q^2-Q^2

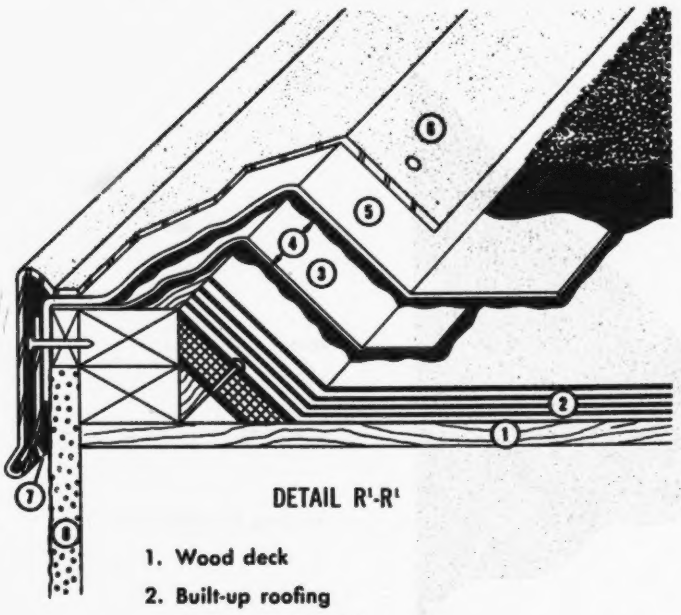
1. Steel deck
2. Insulation
3. Built-up roofing
4. Wood nailer
5. Asphalt mopping
6. Yellow jacket glass fabric (6" wide)
7. No. 15 asphalt felt (12" wide)
8. Gravel stop



DETAIL Q^3-Q^3

1. Gravel stop
    a. Roof flange—4" to 5½"
    b. Rise—¾" max.
    c. Fascia—3½" max. (24 ga.)
2. Roofing felts
3. Asphalt mopping
4. Yellow jacket glass fabric (6" wide)
5. No. 15 asphalt felt (12" wide)

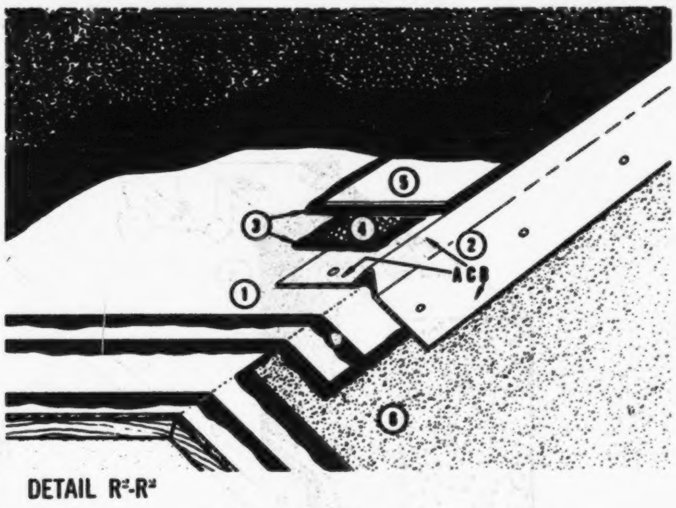
Fig. F-21. Gravel stop details



⑥
⑤
④
③
②
①
⑦
⑧
DETAIL R¹-R¹

1. Wood deck
2. Built-up roofing
3. No. 15 asphalt felt
4. Asphalt mopping
5. Mineral surfaced capsheet
6. Combination metal coping and edging
7. Metal clip
8. Wall

Fig. F-22. Low parapet wall flashing

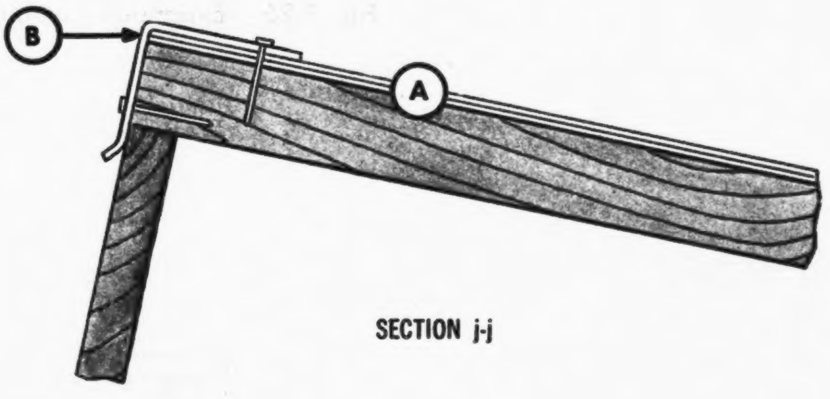


⑤
③
④
②
A C B
①
⑥
DETAIL R²-R²

1. Built-up roofing
2. Flat-to-steep flashing
   a. 4-in. flange
   b. 6-in. flange
   c. ¾-in. rise (max.)
3. Asphalt mopping
4. Yellow jacket glass fabric (6" wide)
5. No. 15 asphalt felt (12" wide)
6. Built-up roofing or asphalt shingles

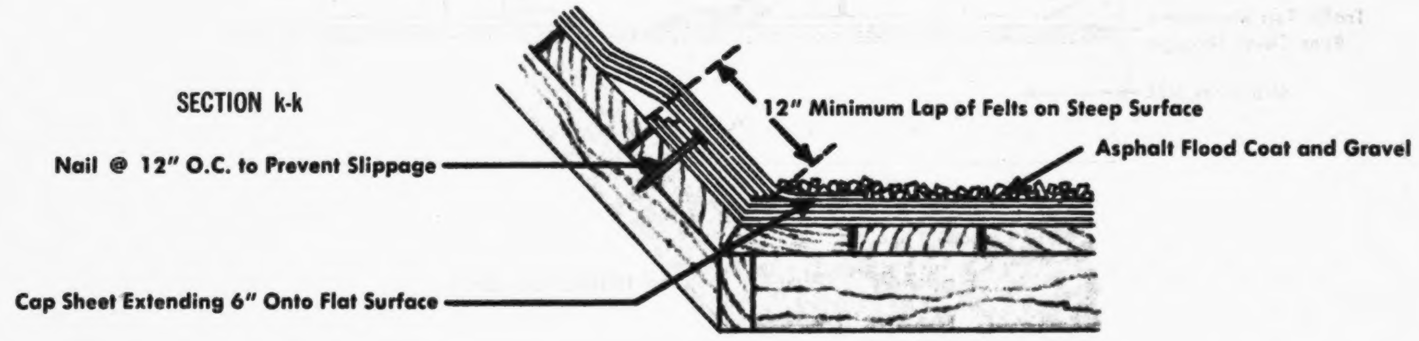
Fig. F-23. Flat-to-steep flashing

A. Built-up capsheet roof
B. Galvanized metal angle, nailed every 6 in.



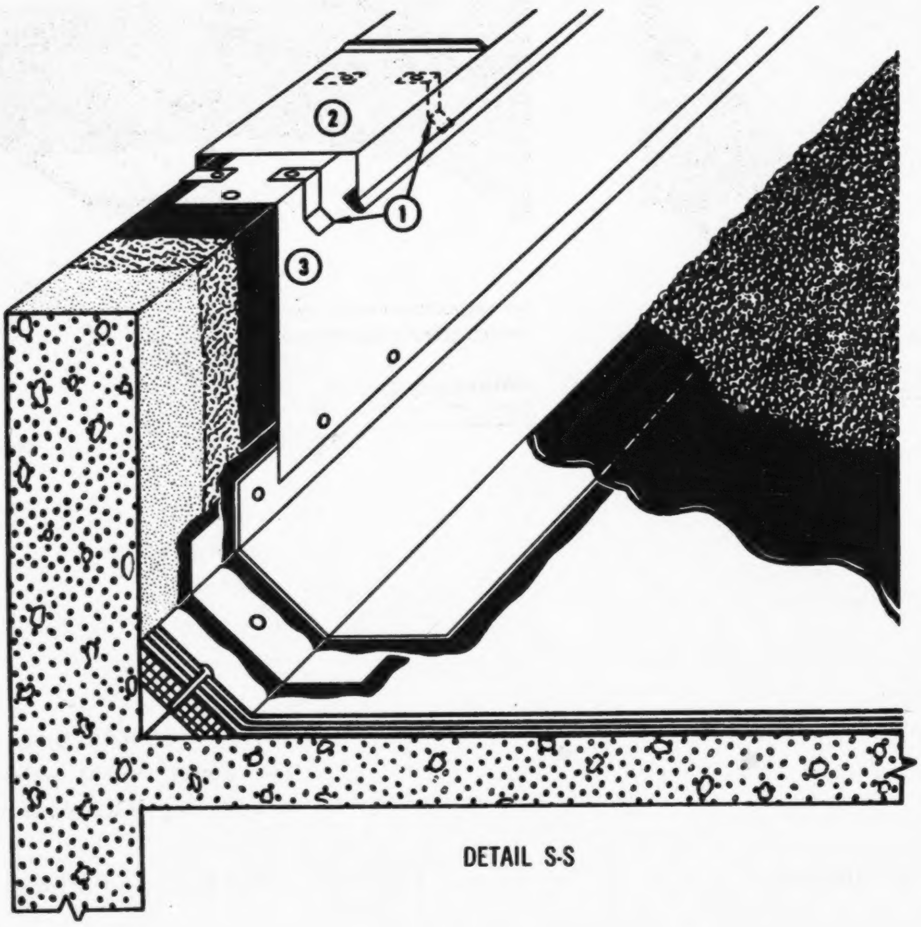
B
A
SECTION j-j

Fig. F-24. Metal ridge cap



SECTION k-k
12" Minimum Lap of Felts on Steep Surface
Nail @ 12" O.C. to Prevent Slippage
Asphalt Flood Coat and Gravel
Cap Sheet Extending 6" Onto Flat Surface

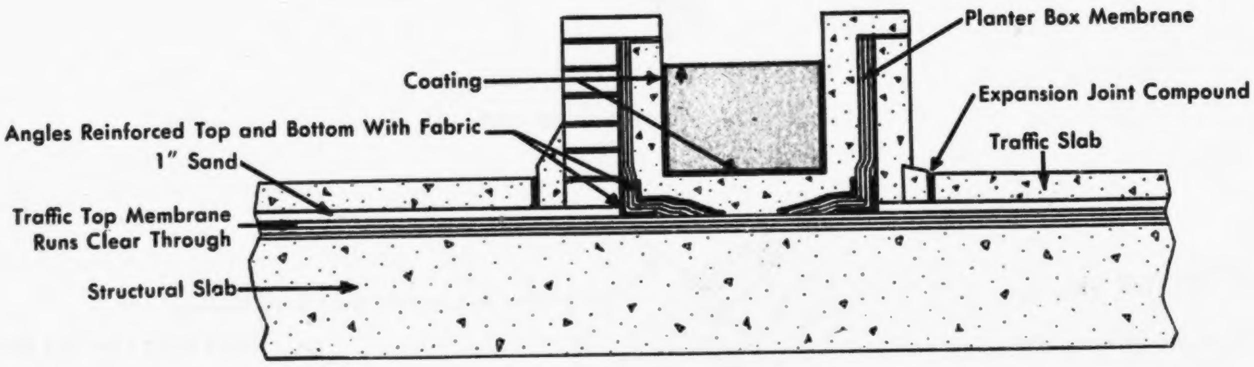
Fig. F-25. Steep-to-flat roof transition



1. Metal holding clip
2. Standing seam metal coping
3. Roofing felt wall covering

DETAIL S-S

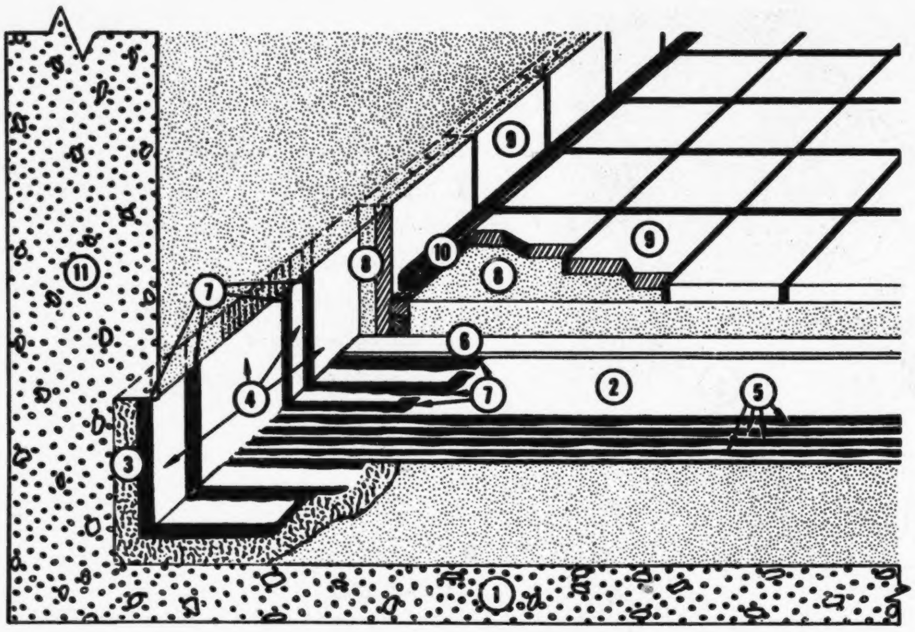
Fig. F-26. Expansion joint metal coping



Planter Box Membrane
Coating
Expansion Joint Compound
Angles Reinforced Top and Bottom With Fabric
Traffic Slab
1" Sand
Traffic Top Membrane Runs Clear Through
Structural Slab

SECTION m-m

Fig. F-27. Planter box on traffic top deck

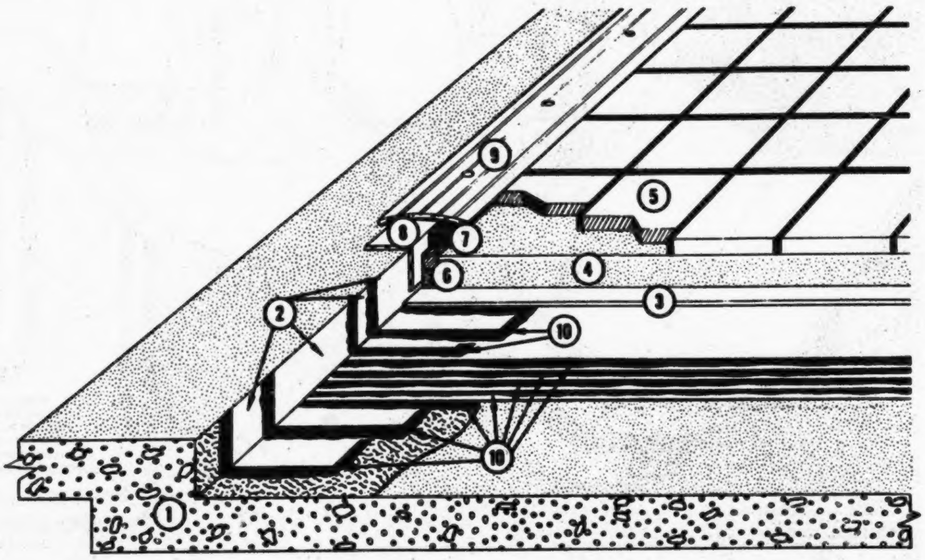


1. Concrete deck
2. Built-up membrane assembly
3. Asphalt primer
4. Reinforcing strips
5. Asphalt mopping
6. Super flaxine protection sheet
7. Flashing compound
8. Mortar setting bed
9. Promenade tile
10. Expansion joint sealer
11. Masonry parapet wall

DETAIL T^1-T^1

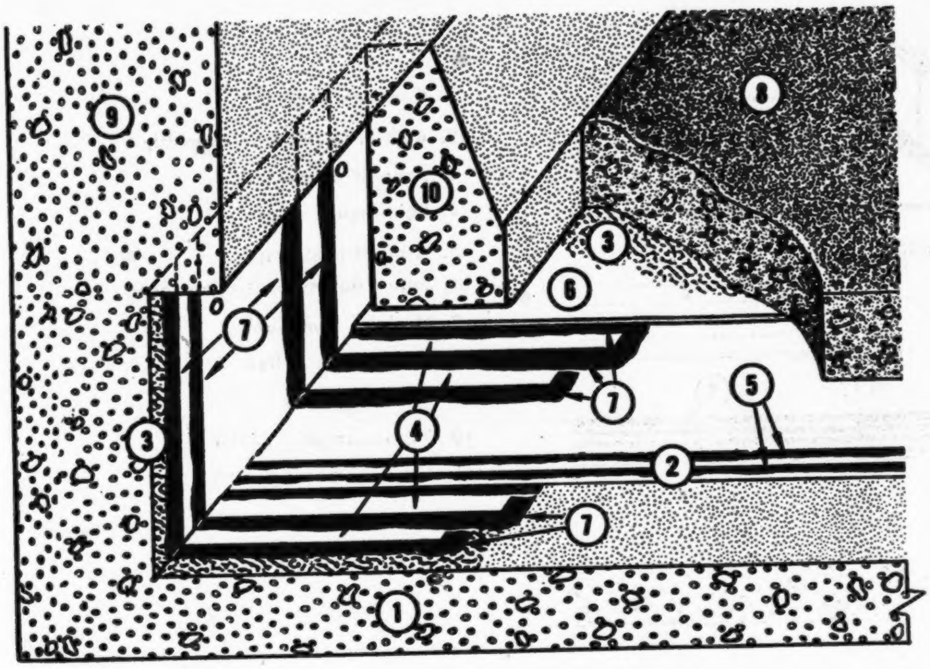
Fig. F-28. Wall flashing for promenade tile topping

1. Base slab and curb
2. Reinforcing strips
3. Membrane
4. Grout fill
5. Promenade tile
6. Filler strip
7. Joint sealer
8. Metal counterflashing
9. Threshold
10. Flashing compound



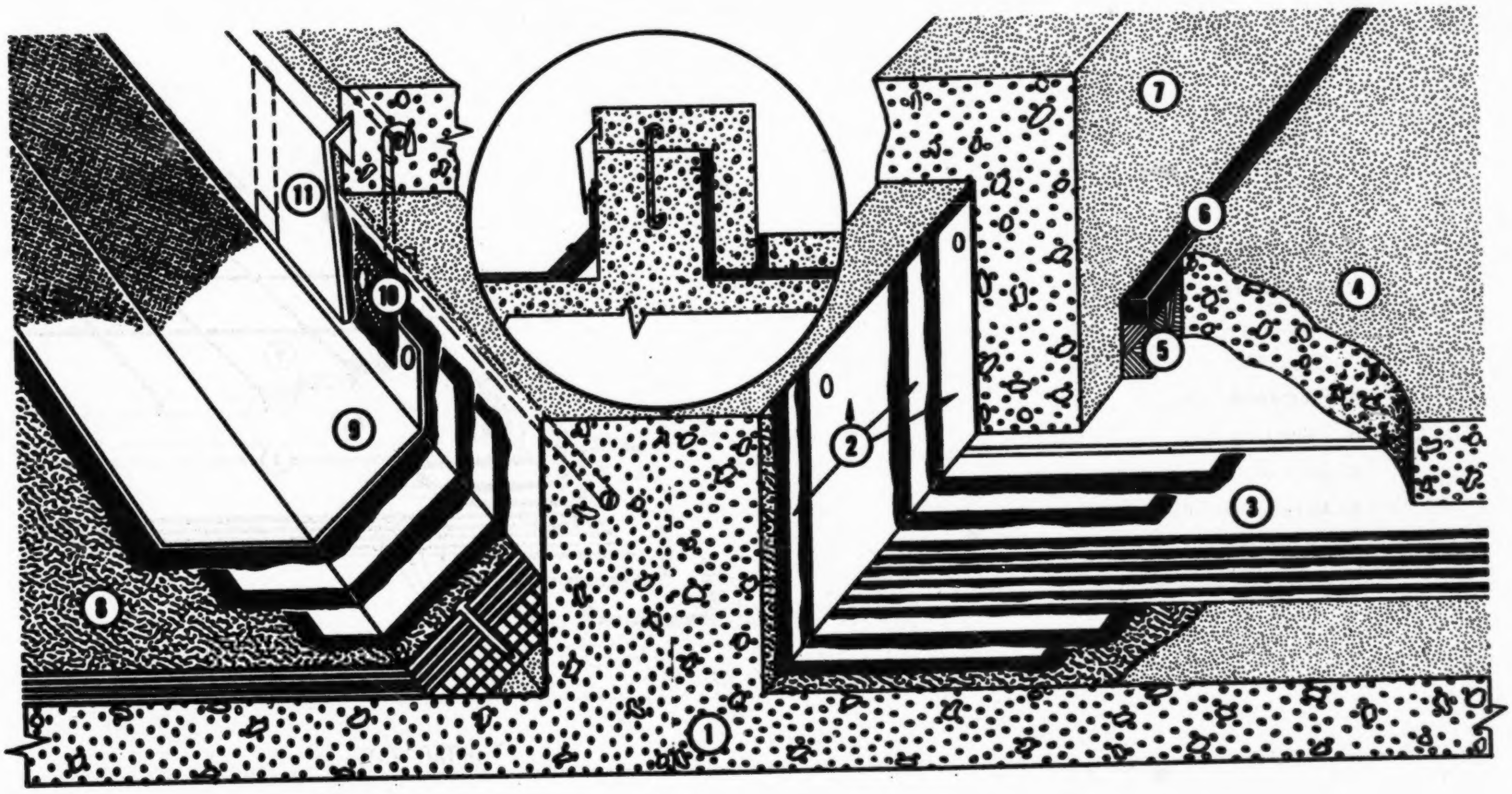
DETAIL T^2-T^2

Fig. F-29. Threshold flashing for promenade tile topping



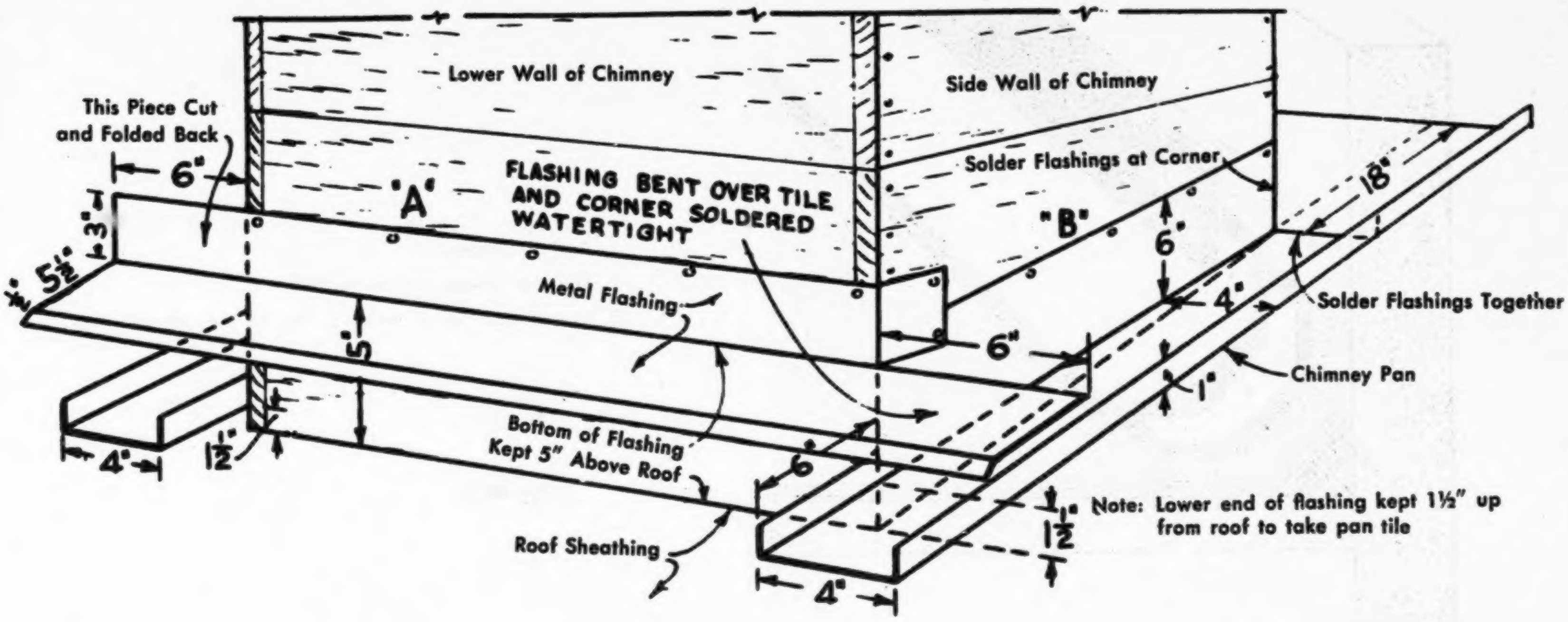
1. Concrete deck
2. Built-up membrane assembly
3. Asphalt primer
4. Reinforcing strips
5. Asphalt mopping
6. Mineral surfaced capsheet
7. Flashing compound
8. Asphaltic concrete topping
9. Masonry wall
10. Concrete curb

Fig. F-30. Vertical wall flashing for asphalt concrete topping

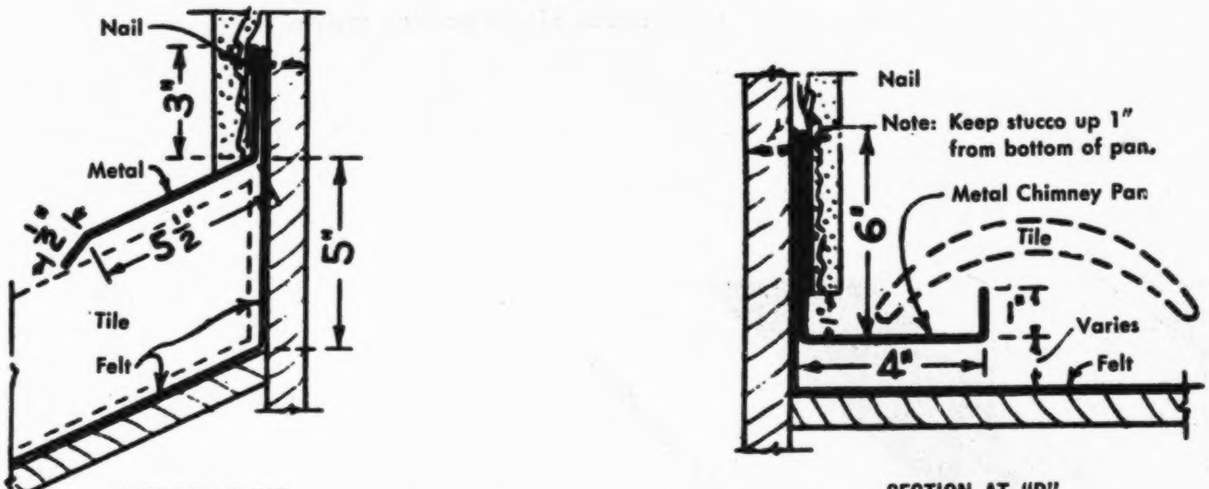


1. Base slab and curb
2. Reinforcing strips
3. Membrane
4. Topping slab
5. Filler strip
6. Joint sealer
7. Counterflashing curb
8. Built-up roofing
9. Base flashing
10. Three-course plastic flashing
11. Metal counterflashing and reglet

Fig. F-31. Combination roof and concrete topping flashing

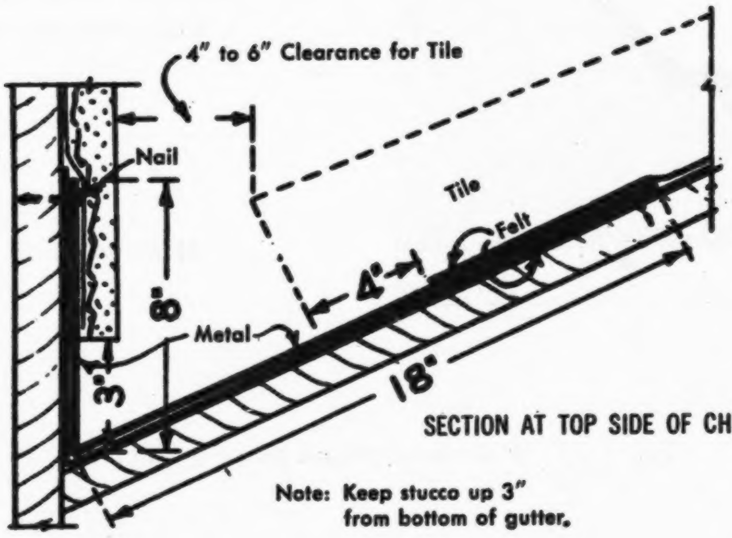

Lower Wall of Chimney
Side Wall of Chimney
This Piece Cut and Folded Back
6"
3"
5½"
½"
"A"
FLASHING BENT OVER TILE AND CORNER SOLDERED WATERTIGHT
"B"
Solder Flashings at Corner
18"
6"
4"
Solder Flashings Together
Metal Flashing
5"
6"
Chimney Pan
1"
4"
1½"
Bottom of Flashing Kept 5" Above Roof
6"
1½"
Note: Lower end of flashing kept 1½" up from roof to take pan tile
Roof Sheathing
4"

DETAIL V-V


Nail
3"
Metal
½"
5½"
5"
Tile
Felt
Nail
Note: Keep stucco up 1" from bottom of pan.
6"
Metal Chimney Pan
Tile
1"
Varies
4"
Felt

SECTION AT "A"

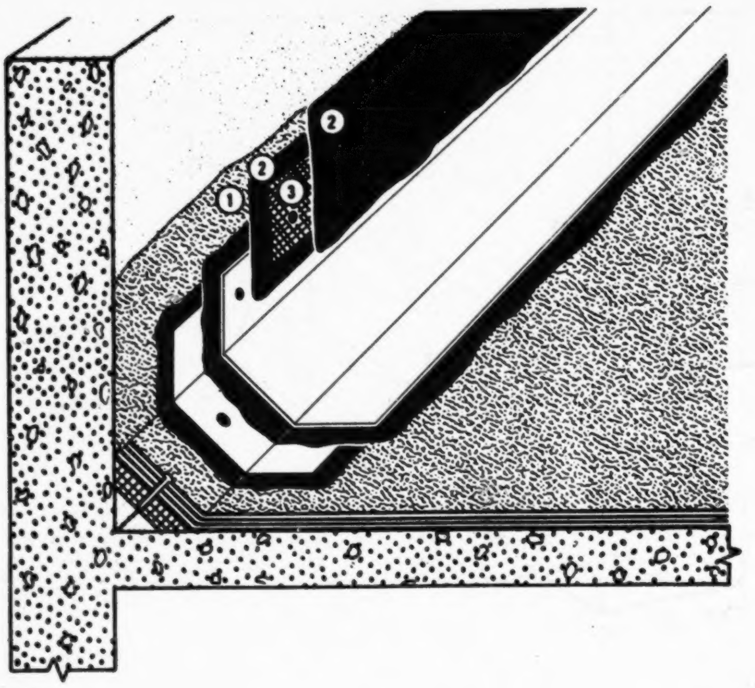
SECTION AT "B"


4" to 6" Clearance for Tile
Nail
Tile
Felt
8"
4"
Metal
3"
18"

SECTION AT TOP SIDE OF CHIMNEY

Note: Keep stucco up 3" from bottom of gutter.

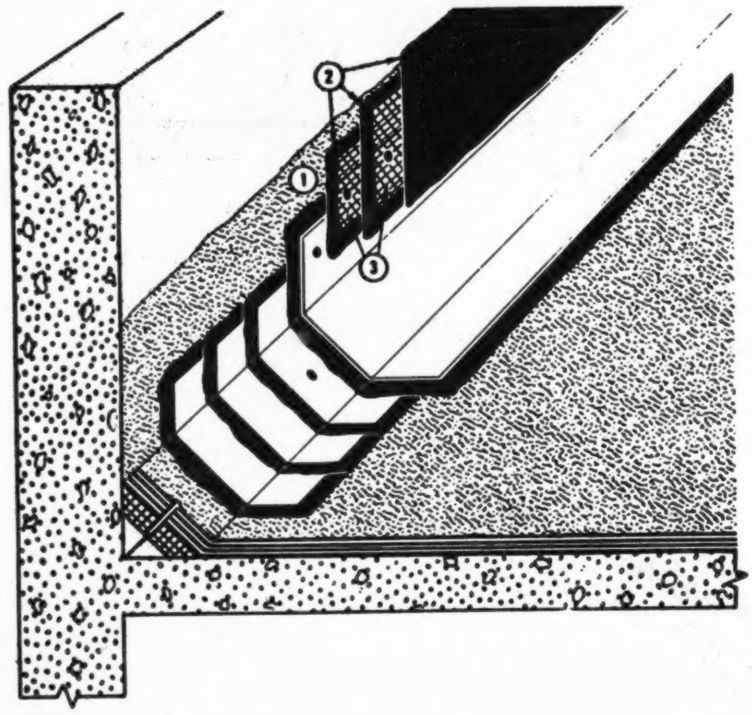
Fig. F-32. Chimney flashing using channel and chimney pan



1. Asphalt primer
2. Flashing compound (⅛ in. thick)
3. Yellow jacket glass fabric or No. 15 asbestos felt strip

DETAIL W^1-W^1

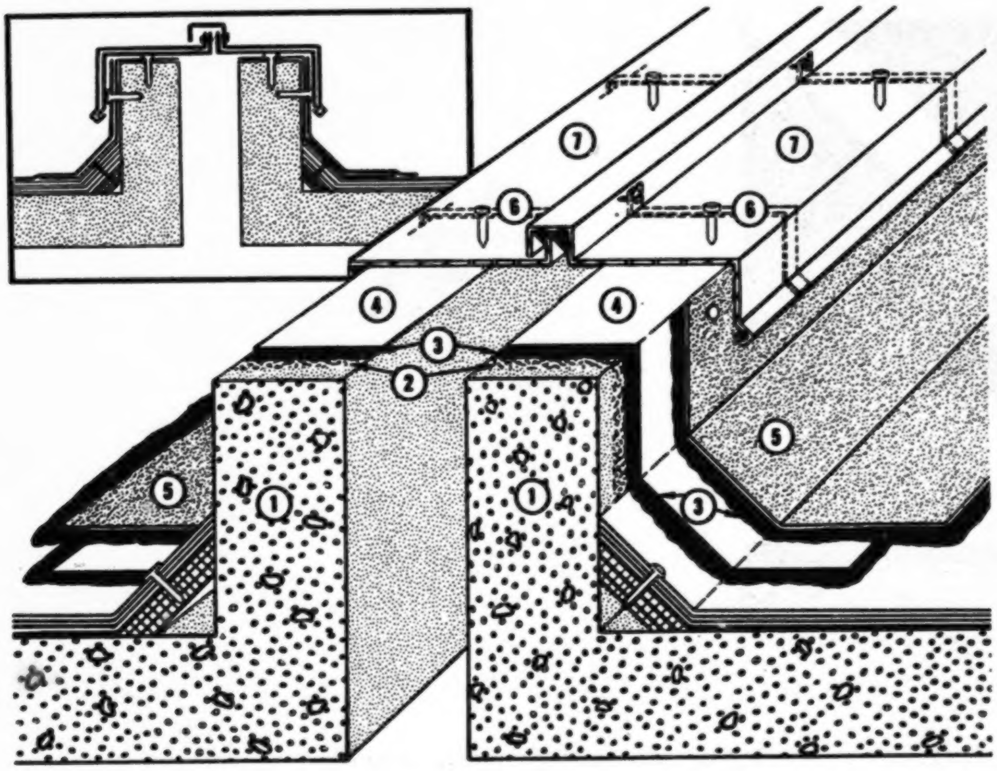
Fig. F-33. Three-course plastic flashing system



1. Asphalt primer
2. Flashing compound (⅛ in. thick)
3. Yellow jacket glass fabric or No. 15 asbestos felt strip

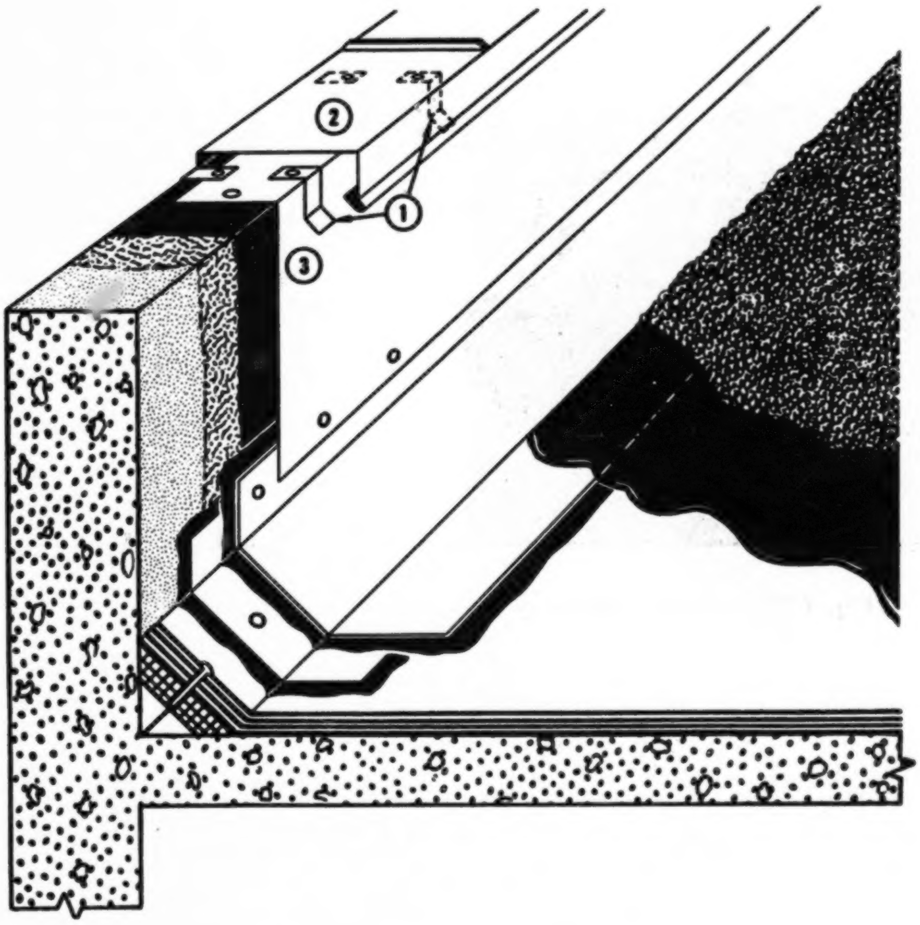
DETAIL W^2-W^2

Fig. F-34. Five-course plastic flashing system



1. Masonry curbs
2. Asphalt primer
3. Asphalt mopping
4. No. 15 asphalt felt
5. Mineral surfaced capsheet
6. Anchor clips
7. Expansion coping

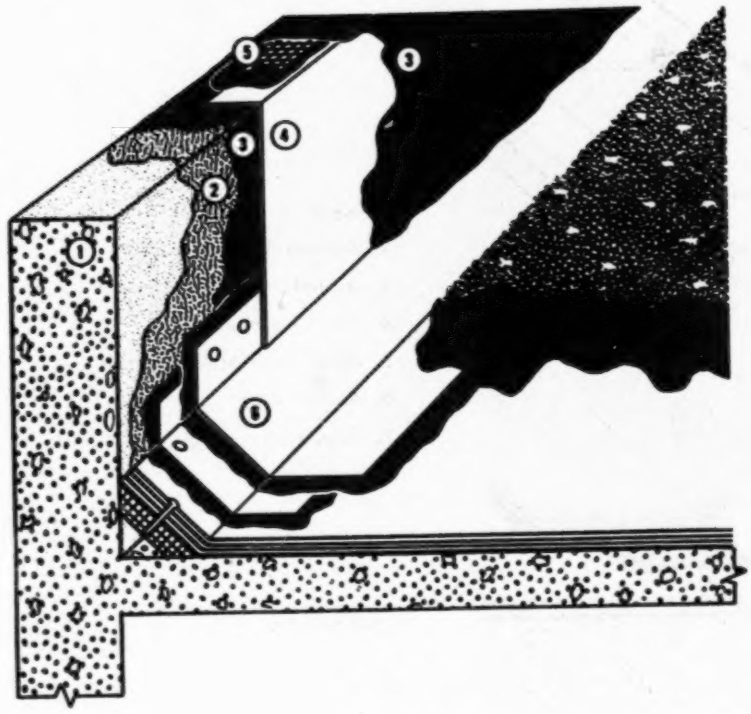
DETAIL X-X



1. Metal holding clip
2. Standing seam metal coping
3. Roofing felt wall covering

DETAIL Y-Y

Fig. F-35. Expansion joint metal coping



1. Masonry parapet wall
2. Asphalt primer
3. Asphalt mopping
4. 45-lb. asbestos sheet
5. Three-course plastic flashing
6. Base flashing

DETAIL Z-Z

Fig. F-36. Parapet wall flashing of asbestos felt and hot asphalt

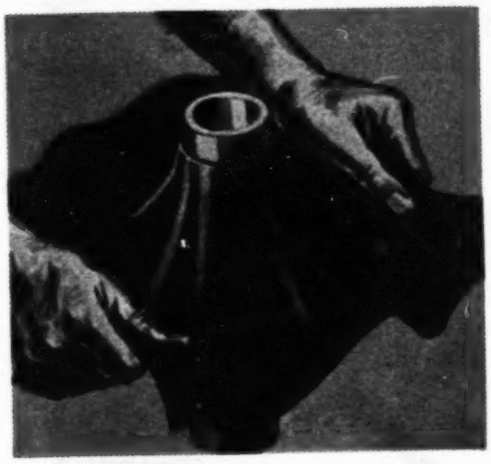
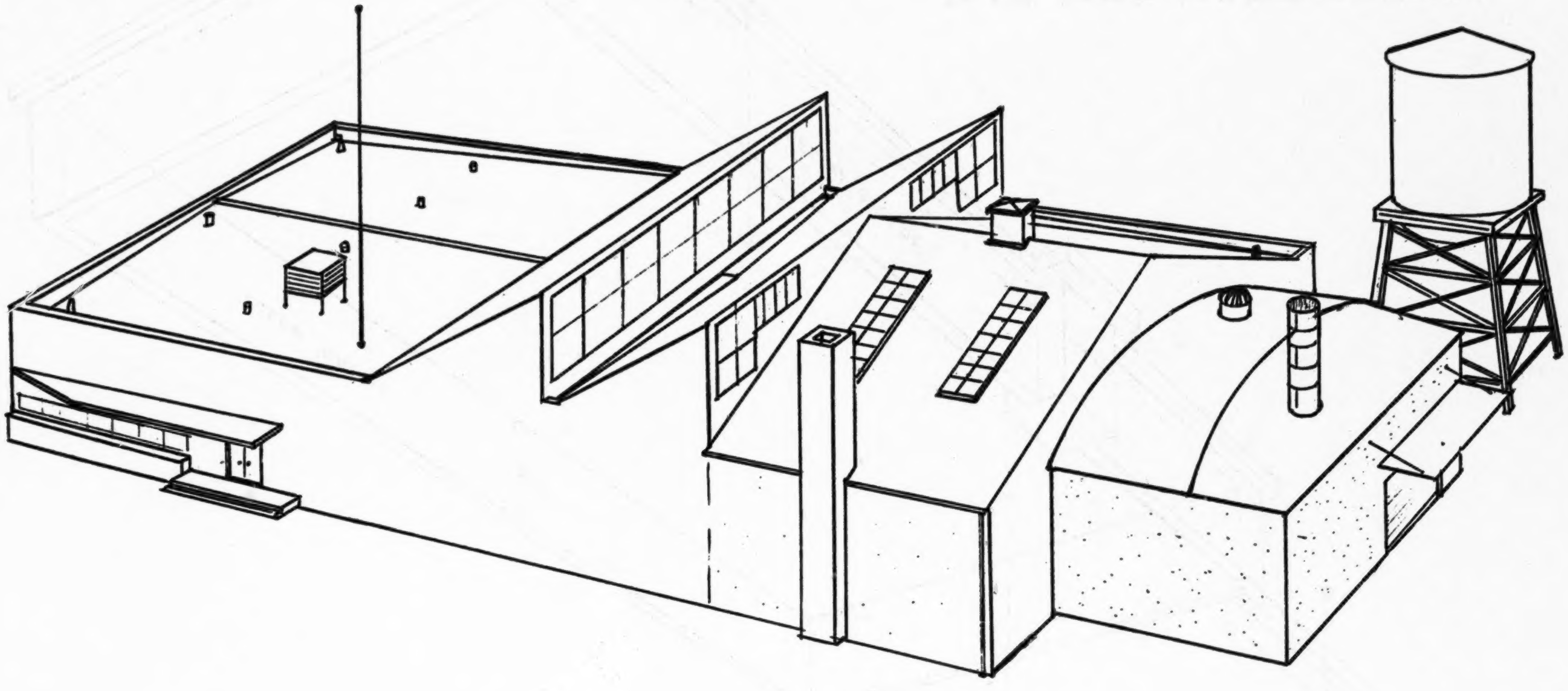


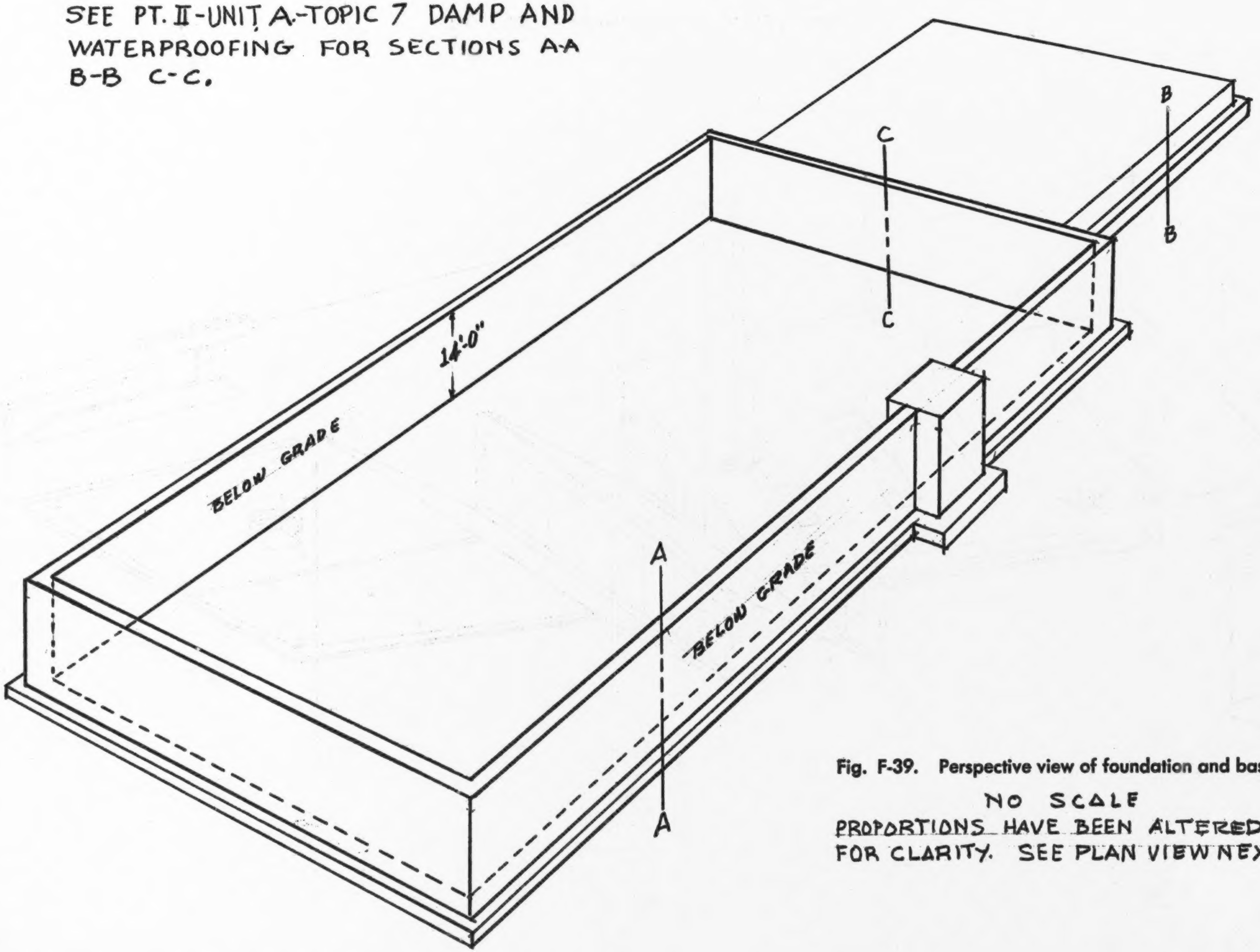
Fig. F-37. Flexible flashing



No Scale

Fig. F-38. Perspective view of factory building

SEE PT. II-UNIT A.-TOPIC 7 DAMP AND WATERPROOFING FOR SECTIONS A-A B-B C-C.



B
B
C
C
14'-0"
BELOW GRADE
A
A
BELOW GRADE

Fig. F-39. Perspective view of foundation and basement

NO SCALE

PROPORTIONS HAVE BEEN ALTERED FOR CLARITY. SEE PLAN VIEW NEXT PAGE.

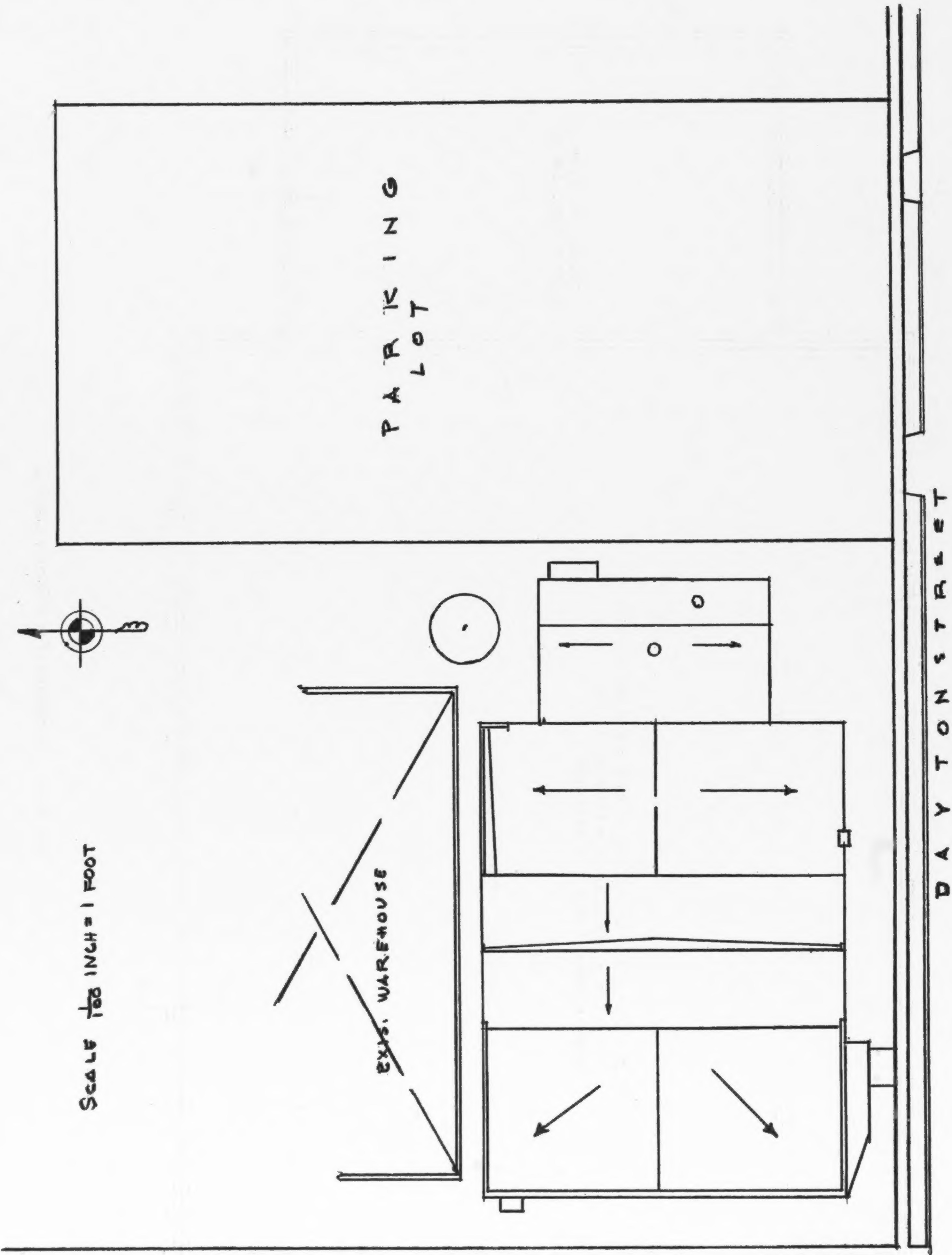

SCALE 1/100 INCH = 1 FOOT
PARKING LOT
EXIS. WAREHOUSE
DAYTON STREET
MAIN STREET

Fig. F-40. Plot plan of factory building

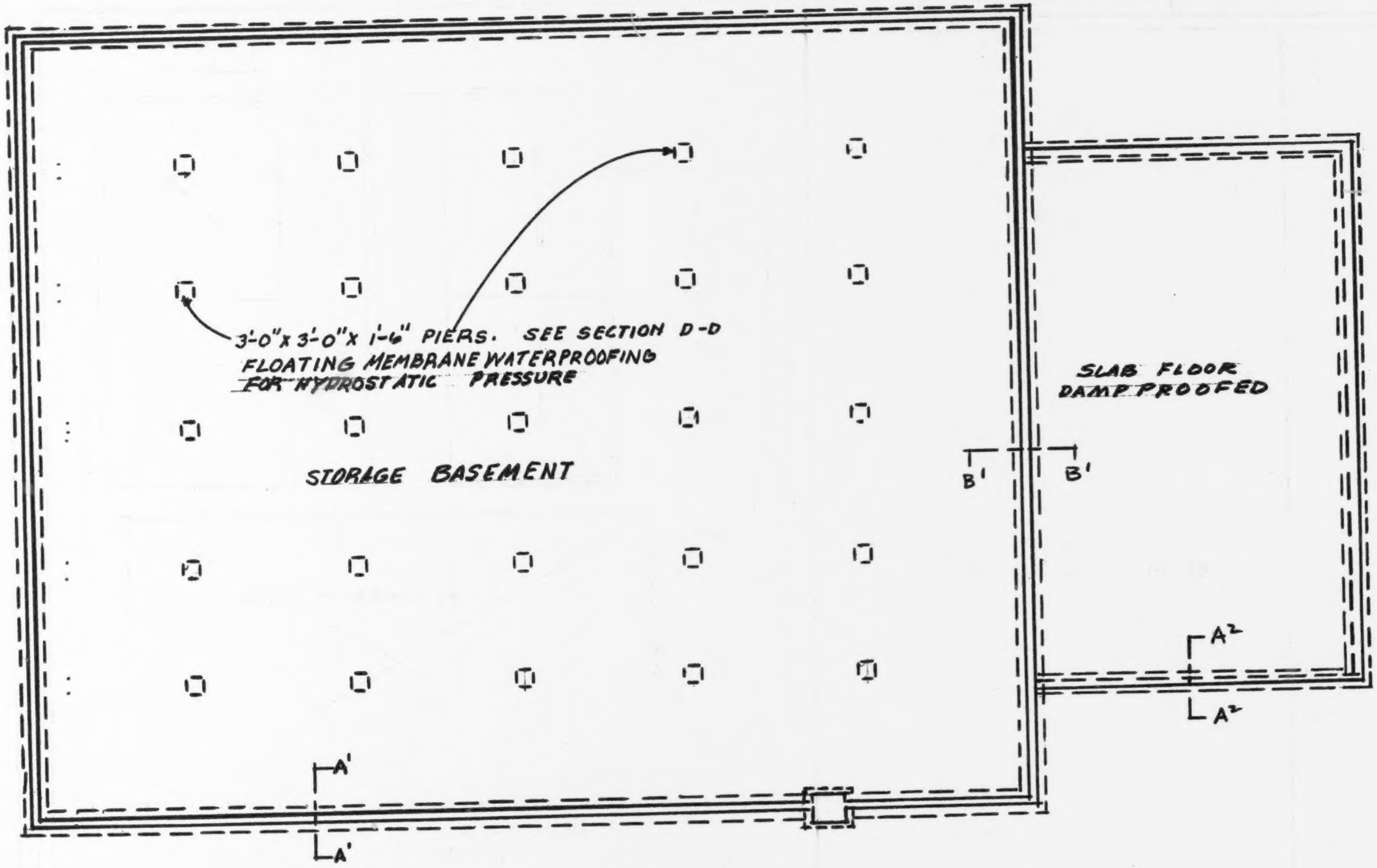

3'-0"x 3'-0"x 1'-6" PIERS. SEE SECTION D-D
FLOATING MEMBRANE WATERPROOFING
FOR HYDROSTATIC PRESSURE
STORAGE BASEMENT
SLAB FLOOR
DAMP PROOFED
B'
B'
A²
A²
A'
A'

Fig. F-41. Foundation plan of factory building

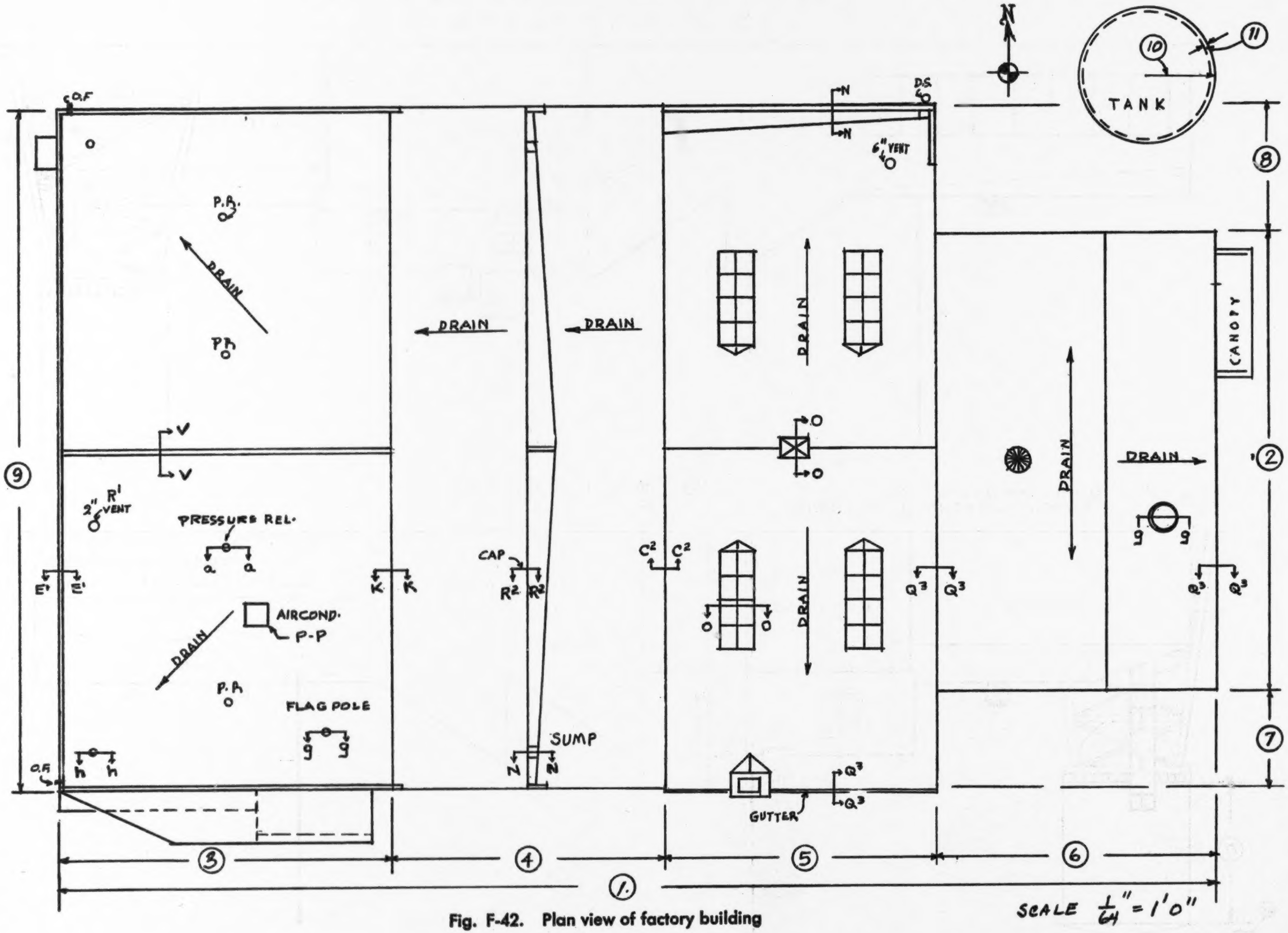
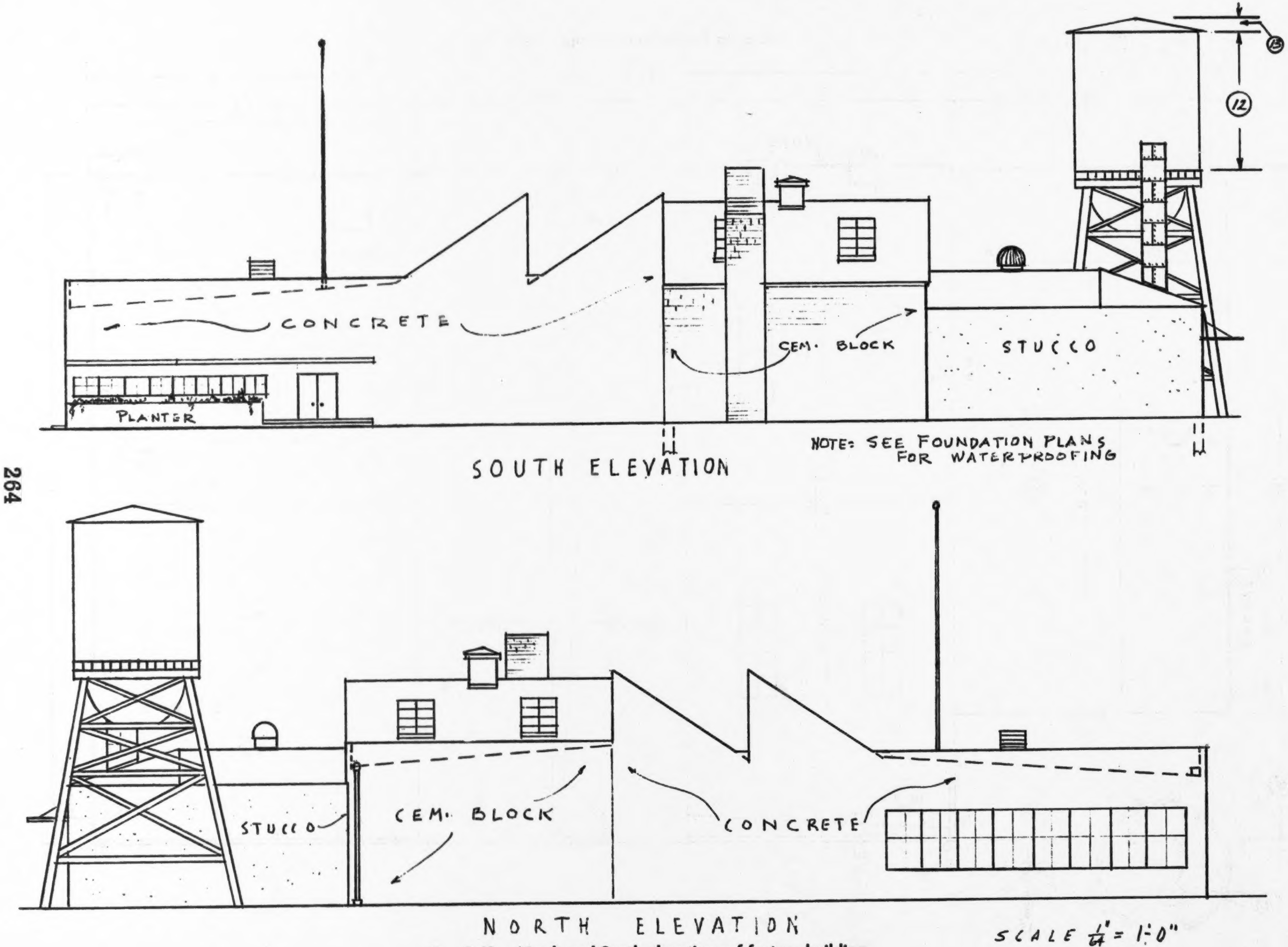

N
TANK
⑩
⑪
⑧
②
⑦
⑨
③
④
⑤
⑥
①
C.O.F
D.S.
6" VENT
N
N
P.R.
P.R.
P.R.
DRAIN
DRAIN
DRAIN
DRAIN
DRAIN
DRAIN
DRAIN
DRAIN
V
V
R¹
2" VENT
PRESSURE REL.
a
a
E¹
E¹
K
K
AIRCOND.
P-P
FLAG POLE
g
g
h
h
O.F.
CAP
R²
R²
SUMP
N
N
C²
C²
O
O
O
O
Q³
Q³
Q³
Q³
Q³
Q³
GUTTER
g
g
CANOPY
SCALE 1/64" = 1'0"

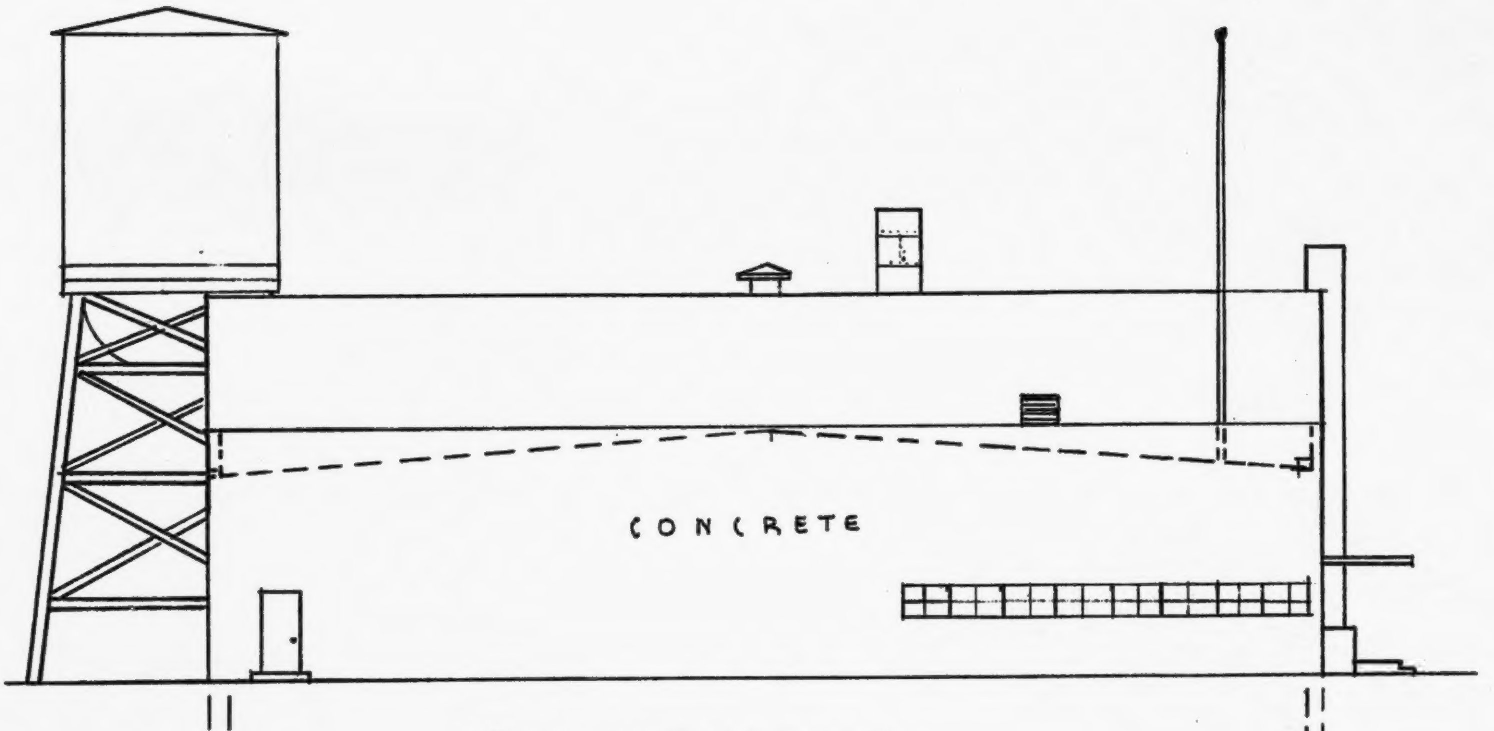
Fig. F-42. Plan view of factory building


⑫
⑬
CONCRETE
CEM. BLOCK
STUCCO
PLANTER
NOTE: SEE FOUNDATION PLANS FOR WATERPROOFING
CEM. BLOCK
STUCCO
CONCRETE
SCALE 1/64" = 1'-0"

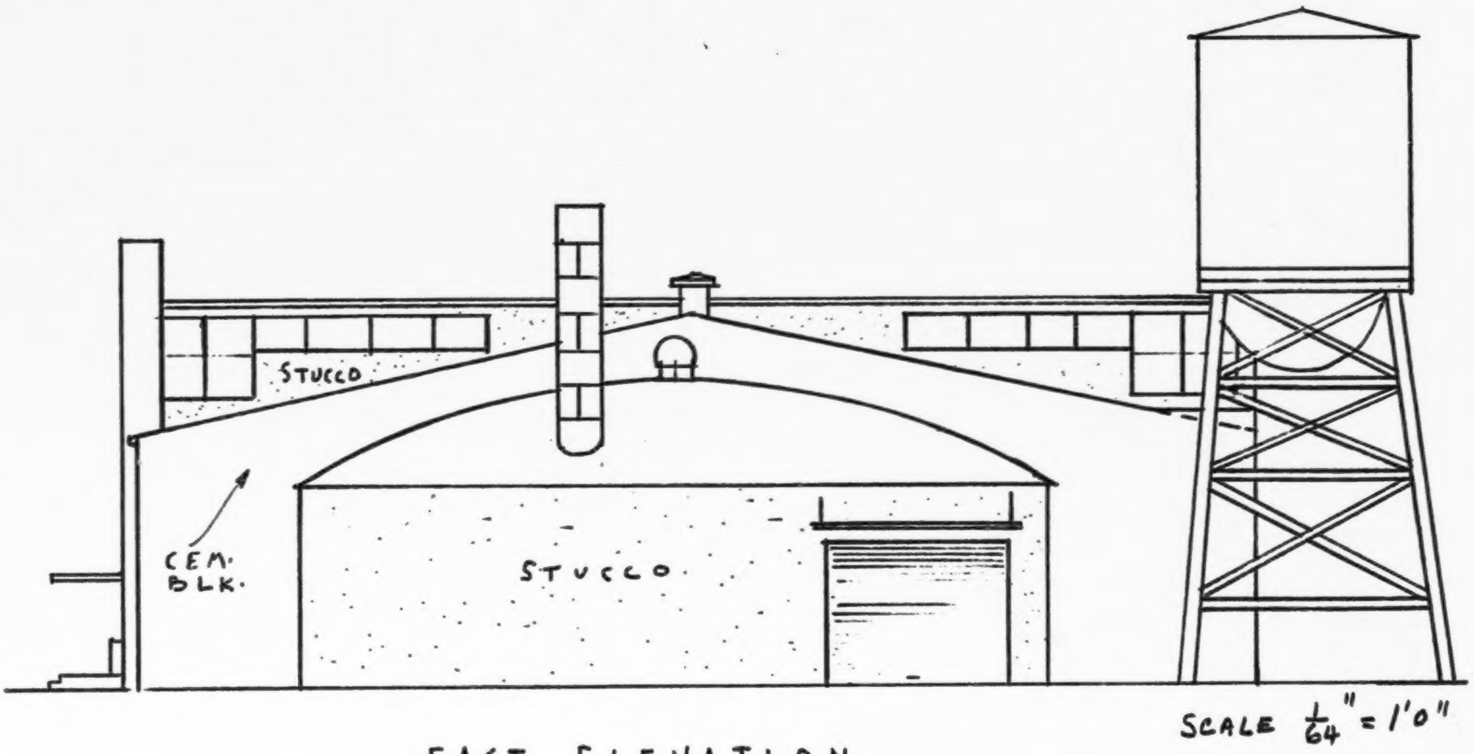
SOUTH ELEVATION

NORTH ELEVATION

Fig. F-43. North and South elevations of factory building



WEST ELEVATION


STUCCO
CEM. BLK.
STUCCO
SCALE $\frac{1}{64}$" = 1'0"

EAST ELEVATION

Fig. F-44. East and West elevations of factory building